Evaluating aetiologies, treatment strategies and optimizing outcomes in pseudoaneurysms

Dissertation submitted for the partial fulfillment of the regulations for the award of the degree of

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“Learn to heal”

DECLARATION

I solemnly declare that this dissertation titled "**Evaluating aetiologies, treatment strategies and optimizing outcomes in pseudoaneurysms" w**as prepared by me in the Department of Vascular Surgery, Rajiv Gandhi Government General Hospital, Chennai under the guidance and supervision of **Prof T. Vidyasagaran**, Professor & Head of the Department, Department of Vascular Surgery, Rajiv Gandhi Government General Hospital, Chennai. This dissertation is submitted to The Tamil Nadu Dr. MGR Medical University, Chennai in partial fulfilment of the university requirements for the award of the degree of M.Ch. Vascular Surgery.

Place: Chennai

Date: 12.03.2012 **DR ARUNAGIRI.V**

CERTIFICATE

This is to certify that the dissertation titled "**Evaluating aetiologies, treatment strategies and optimizing outcomes in pseudoaneurysms"** submitted by **Dr Arunagiri.V** appearing for **M.Ch (Vascular Surgery)** degree examination in August 2012, is a bonafide record of work done by him under my guidance and supervision in partial fulfilment of requirement of The Tamilnadu Dr M G R Medical University, Chennai. I forward this to The Tamilnadu Dr M G R Medical University, Chennai.

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Finally, I thank the almighty for seeing me through.

CONTENTS

ABBREVIATIONS

PAD	-	Peripheral arterial disease
DM	-	Diabetes mellitus
HTN	-	Hypertension
CAD	-	Coronary artery disease
RHD	-	Rheumatic Heart disease
IE	-	Infective endocarditis
CKD	-	Chronic Kidney disease
CCA	-	Common carotid artery
ICA	-	Internal carotid artery
SCA	-	Subclavian artery
BA	-	Brachial artery
CIA	-	Common iliac artery
EIA	-	External iliac artery
IIA	-	Internal iliac artery
CFA	-	Common femoral artery
PFA	-	Profunda femoris artery
SFA	-	Superficial Femoral artery
ATA	-	Anterior tibial artery
PTA	-	Posterior tibial artery
USG	-	Ultrasound
CT	-	Computed tomography
CTA	-	CT angiography
DSA	-	Digital subtraction angiography
OPD	-	Outpatient department
RT	-	Right
LT	-	Left
PTFE	-	Poly tetra- fluoro ethylene
AVF	-	Arterio-Venous fistula

Introduction

A pseudoaneurysm (false aneurysm) by definition results from a leakage of blood from an artery after trauma or after dehiscence of a surgical anastomosis. The wall of the false aneurysm is composed of the compressed, surrounding tissues, not the wall of the artery from which the lesion arises. It is not lined by all three layers of the arterial wall.

There are various etiologies for pseudoaneurysms like post anastomotic, post traumatic, infective, iatrogenic and idiopathic. We will have a brief overview on each of them.

In 1956, Claytor and associates reported the first case of anastomotic aneurysm in a patient after prosthetic aortic graft placement. Since then, anastomotic aneurysms have been recognized as an infrequent though important late complication of prosthetic arterial reconstruction. Though true native aneurysmal degeneration may occur at any anastomotic site, most anastomotic aneurysms are considered *false* aneurysms as they are composed of a fibrous pseudo capsule and not the normal component layers of the arterial wall. Notably, anastomotic aneurysms are associated with potential significant morbidity and mortality, and they present clinical challenges in their detection, evaluation, and management.

Overall, anastomotic aneurysms complicate 1.4% to 4% of arterial anastomosis. The incidence of anastomotic aneurysms, however, is influenced substantially by anatomic location, surgical technique, time from anastomotic construction, intensity of surveillance, and integrity of the host artery at the original operation. The most common anatomic site of anastomotic aneurysm formation is the

femoral artery, where aneurysm occurs substantially more often than at aortic or iliac sites.

Coming to the pathogenesis of anastomotic aneurysms, an anastomosis between two vascular structures is potentially subjected to anastomotic failure and hence anastomotic aneurysm formation. However, anastomotic aneurysms occur almost exclusively at anastomosis between prosthetic grafts and native arteries, with only rare occurrences in completely autogenous anastomosis.

When a suture line or anastomosis between two vascular structures is disrupted, an anastomotic aneurysm may form. The egress of blood from the anastomotic defect forms a pulsatile hematoma that, while in continuity with the bloodstream, becomes lined peripherally with laminated thrombus and eventually becomes encapsulated by surrounding host tissue. A fibroblastic process that initiates the formation of a tissue capsule ensues. The capsule, essentially a false aneurysm cavity, is subjected to systemic arterial pressure and may gradually enlarge, occasionally resulting in rupture, local complications of expansion, or distal embolization.

Several factors are associated with the development of anastomotic aneurysms.

LOCAL	**SYSTEMIC**
• Arterial wall degeneration • Suture line disruption • Prosthetic graft failure • Infection/inflammation • Technical errors • Mechanical stress	• Smoking • Hyperlipidemia • Hypertension • Anticoagulation • Systemic vasculitides • Generalized arterial weakness

False aneurysms of peripheral arteries are rare and in most cases, these are the result of penetrating injuries, such as gunshot or stab wounds, and iatrogenic arterial injury. Fractures as well as blunt trauma have also been reported as causes. These aneurysms are much less frequent in the upper extremity than in the lower extremity and they can even cause the loss of the extremity.

An aneurysm is formed over weeks or even months .Classically, a false aneurysm appears as a pulsatile swelling at the fracture site. Increased intracompartmental pressure and associated venous edema may cause skin necrosis and subsequent ulceration. Meanwhile, peripheral pulses can be preserved by the collateral blood supply.

Pseudoaneurysms may occur in the setting of repetitious vocational injuries such as axillary artery side branch disruptions in professional baseball pitchers and ulnar artery disruptions across the hook of the hamate bone in pipe fitters, truck mechanics, volleyball players, and mountain bike riders. In these situations the resulting pseudoaneurysms typically predispose to distal and digital embolization rather than rupture.

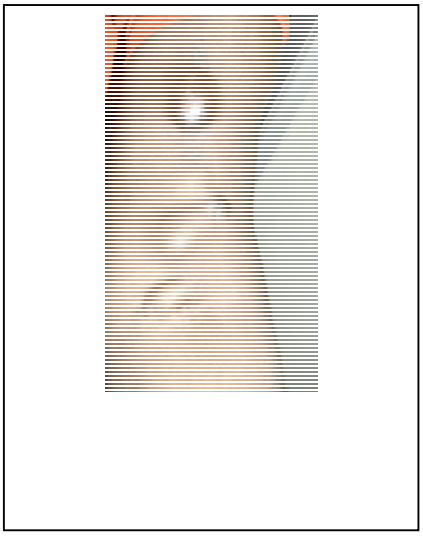
Infected aneurysms have been reported in practically every arterial segment, and although these aneurysms represent only a very small proportion of all aneurysms, they are among the most difficult to treat. The vascular surgeon is often

faced with a patient compromised by sepsis, artery rupture, and challenging anatomic locations of aneurysms, which may obviate simple excision as a viable treatment option.

In 1885, Osler presented the first comprehensive discussion of an infected aneurysm and remarked on the anatomical characters, clinical features and etiological and pathological relations.

In more recent years, the incidence of arterial infections and infected aneurysms has increased in response to the increasing prevalence of immunosuppressed hosts, invasive hemodynamic monitoring, angiography and drug addiction. As a result of developing treatment modalities that use catheter-based percutaneous approaches for a variety of occlusive or aneurysmal vascular lesions, iatrogenic infected false aneurysms seem to be increasing in frequency

Another major subgroup of patients with pseudoaneurysms are those following AV access procedures. Patients with Stage V CKD undergo AV access procedures for maintenance haemodialysis. Such patients can develop pseudoaneurysms over a period of time. Venous pseudoaneurysms typically occur at the site of clustered needle punctures, with resultant degeneration of the vein wall. Venous pseudoaneurysms are typically saccular and more prone to infection and rupture.



Another subset of patients is iatrogenic pseudoaneurysms that present after an unrecognized injury during surgical procedures. There have been case reports of these injuries but they have not been analyzed in detail in literature. By literature the common pseudoaneurysms that are encountered in modern day practice are those following percutaneous catheter based diagnostic or therapeutic procedures. They are commonly found in the femoral artery. We would like to discuss the various spectrums of pseudoaneurysms that had presented to our department, their clinical presentation and management strategies.

Review of Literature

Overall, anastomotic aneurysms complicate 1.4% to 4% of arterial anastomosis. When reporting incidence, anastomotic aneurysm formation may be described by number of patients or more accurately, by number of anastomosis at risk. Because anastomotic aneurysms form with the highest incidence at femoral anastomosis, each patient may have two or more sites at risk for aneurysm development, and thus by incidence anastomotic site appears more informative.

The interval to presentation of anastomotic aneurysm has changed dramatically. Previously an early phenomenon, anastomotic aneurysms in most modern series present at a mean of 6 years following graft implantation. **Associated infection often shortens this interval**. Ironically, anastomotic aneurysms after reconstruction for Aorto-iliac occlusive disease are more likely to have late presentations (15.8 years versus 8.9 years for non occlusive disease) and are more likely to represent degeneration of the anastomosis rather than true aneurysmal change.

As noted above, the most common anatomic site of anastomotic aneurysm formation is the femoral artery, where aneurysm occurs substantially more often than at aortic or iliac sites. Anastomotic aneurysms have been reported to complicate 0.5% to 23.7% of femoral artery reconstructions. In a large retrospective analysis of anastomotic aneurysms after prosthetic reconstructions for aortoiliac occlusive disease, van den Akker and associates reported an incidence per patient of 13.3% and an incidence per anastomotic site of 4.8%, 6.3%, and 13.6% for aortic, iliac, and femoral anastomosis, respectively. This propensity of anastomotic aneurysms to form at the femoral location has been documented by others.

Anastomotic pseudoaneurysms are associated with a high risk of rupture and repair is complicated by high rates of postoperative mortality and morbidity. Mulder et al reported that 44% of patients with untreated anastomotic pseudoaneurysms died of documented rupture after a mean follow-up of 6 years. Among those patients who underwent repair of the pseudoaneurysm, the postoperative mortality rate was 7.6% and the morbidity rate was 17%.

Large retrospective studies of graft-related complications for abdominal aortic aneurysm repair report a cumulative incidence of anastomotic aneurysm of 1.3% to 3.0%.However, the incidences of aortic and iliac anastomotic aneurysms are probably underestimated because of inadequate surveillance, prolonged time to recognition, and their initially quiescent behaviour. Moreover, studies with routine radiologic surveillance estimate the incidence of anastomotic aneurysms of the aorta and iliac arteries to be approximately 10% and it may reach 27% at 15 years.

Post-traumatic pseudoaneurysms are not a rare event in military facilities during periods of armed conflicts, but are infrequently seen in the civilian health care system. Pseudoaneurysms and concomitant arteriovenous fistula (AVF) are associated with bone fractures, penetrating or high-injury blunt trauma, sport activities, and less frequently after orthopaedic injuries.

The therapeutic strategy before the endovascular era included artery ligation or reconstruction with autologous material, external compression, coil embolization, or echo-guided thrombin injection. The endovascular approach for peripheral arterial lesions with covered stents has permitted a less traumatic anatomic reconstruction of such lesions.

Post-traumatic infected false aneurysms have become a prevalent type of infected aneurysm in recent decades in clinical practice. The primary factor in this

shifting emphasis in pathogenesis is drug addiction. The femoral triangle, used by narcotic addicts for repeated attempted vein injections, is the most common site in which these lesions occur. Another factor contributing to the increasing incidence of these lesions is the proliferation of various invasive testing and monitoring procedures. In susceptible individuals, percutaneous arterial puncture may result in an iatrogenic post-traumatic infected false aneurysm. Along with the increase in percutaneous endovascular procedures has come the increased use of percutaneous femoral artery closure devices, which may be associated with an increased incidence of infected pseudoaneurysms.

Risk factors for Post catheter based treatment-pseudoaneurysm formation

Procedural factors

Interventional rather than diagnostic procedures

Catheterization of both artery and vein

Catheterization of superficial femoral artery or profunda femoris artery

Poor technique

Low femoral puncture

Inadequate compression post-procedure

Patient factors

Obesity

Anticoagulation

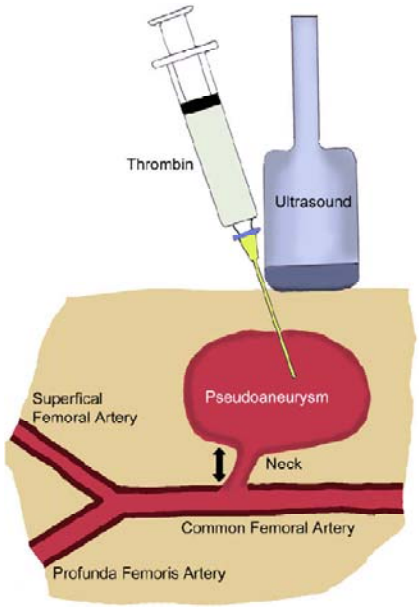
Haemodialysis

Calcified arteries

Clinical discrimination among pseudoaneurysm, hematoma, and arteriovenous fistula may be difficult because of a pulsatile mass in the region. To confirm diagnosis, angiography may be used, but because of the opaque burden and risk of secondary puncture of a femoral artery, this diagnostic procedure is usually postponed. Therefore, color-flow Doppler ultrasonography is the mainstay of differential diagnosis. A systolic flow inside the echolucent mass and a diastolic flow out from the mass (a typical to-and-fro Doppler waveform) are distinctive features of pseudoaneurysms. This Doppler flow phenomenon is equivalent to angiographic systolic jet and diastolic washout appearance. The sensitivity and specificity of the Doppler technique to diagnose FPA are 94% and 97%, respectively.

Since first described by Fellmeth et al. in 1991, colour flow duplex-guided compression repair has become the treatment of choice at many institutions for femoral pseudoaneurysms that result from percutaneous arterial procedures. This technique involves the application of pressure under constant guidance of the colour-flow image to obliterate flow into the pseudoaneurysm chamber, allowing blood in the chamber to thrombose, thereby converting the pseudoaneurysm to a hematoma. Success rates of up to 100% have been reported.

Compression therapy along with thrombin has been used frequently for post angiography pseudoaneurysms where there is a narrow neck without skin ulceration. It has also been applied successfully to pseudoaneurysms arising after punctures at other sites, such as the radial, brachial, subclavian, and popliteal arteries. Potential advantages of this approach over traditional operative repair include cost savings both in terms of reduced operating room fees and decreased length of hospital stay) and reduced patient morbidity.



Perhaps the most feared complication of thrombin injection is escape of thrombin into the peripheral circulation with resulting intra-arterial thrombosis. In fact thrombin is thought to commonly enter the distal circulation but its low concentration and the presence of natural lytic agents in the circulation prevent symptomatic ischemia. Intra-arterial thrombosis is therefore relatively rare, at most 2% of procedures. When manifest it can often be successfully managed with a conservative approach.

Another major subset of patients are those associated with haemodialysis. A major cause of brachial artery pseudoaneurysms is inadvertent arterial puncture during venous cannulation for haemodialysis. Factors that contribute to this complication are use of large-calibre needles, poor puncture technique, and premature puncturing of the fistula after surgery. Patients with brachial artery pseudoaneurysms may present weeks to months later. Common findings include a pulsatile mass, systolic bruit by auscultation, and neuropathy and venous thrombosis from pressure on adjacent nerves and veins. Other associated findings may include rupture of the

pseudoaneurysm, infection, bleeding, and distal arterial insufficiency. Distal embolization of a mural thrombus within a pseudoaneurysm may result in hand ischemia.

Treatment for hemodialysis access aneurysms and pseudoaneurysms include open surgical and percutaneous techniques. Until recently, the standard therapy for aneurysms was open surgical repair with excision or ligation of the pseudoaneurysm, followed by interposition grafting in selected cases. Open surgery typically is performed in cases of access rupture and infection. Percutaneous treatments are intended to maintain patency and function of the existing access while excluding the aneurysm or pseudoaneurysm from the circulation. Percutaneous treatments include endovascular stent or covered stent implantation, coil embolization and ultrasound-guided thrombin injection. The most appropriate treatment must be selected according to the cause, location, size, and accessibility of the pseudoaneurysm.

It depends primarily on the expendability of the donor artery. A pseudoaneurysm that arises from an expendable donor artery and does not have a collateral supply such as a visceral branch (e.g. a segmental or intralobar renal arterial branch) could be treated with embolization of the afferent artery. The materials used in the embolisation of the donor artery including coils, GDC, N-butyl-2-cyanoacrylate (NBCA), polyvinyl alcohol (PVA) particles and gelatin sponge particles. Selecting the optimal embolisation materials depends on the site of the pseudoaneurysm and the anatomy of donor artery.

A pseudoaneurysm arising from an inexpendable donor artery must be excluded from the circulation while preserving the flow in the donor artery. The width of the pseudoaneurysm neck relative to the diameter of the donor artery is the determining factor in the method used. Stent-graft (covered stent) placement across

the neck to exclude the pseudoaneurysm is another option for the treatment of pseudoaneurysm with wide neck and donor artery. This method is relatively contraindicated in mycotic pseudoaneurysm due to potential stent-graft infection.

Despite the growing popularity of imaging guided compression and endoluminal management of pseudoaneurysms, surgical management still plays an important role in pseudoaneurysms with local mass effect complications such as ischemia and neuropathy (in an attempt to rapidly reduce this mass effect), infected pseudoaneurysms, and cases in which therapy with minimally invasive interventional techniques has failed. Moreover, surgical management is preferred in the treatment of pseudoaneurysms with concomitant injury such as fracture.

Aims and Objectives

The purpose of this study was to evaluate the various etiologies, treatment strategies and outcomes of pseudoaneurysms in our population.

Patients and Methods

This study was conducted in the Department of Vascular surgery from August 2009 to January 2012. This was a descriptive study about patients presenting with pseudoaneurysms to the Vascular surgery Out Patient Department and Surgical emergency. Both elective and emergency cases were enrolled.

The elective patients were evaluated with clinical examination, Duplex USG and 64 slice CT angiography in selected patients. Routine blood investigations with blood culture and clot or wall culture were performed. All the emergency cases were evaluated with clinical examination and if hemodynamically stable were subjected to Duplex examination.

Once the diagnosis was confirmed, the patients were subjected to surgical intervention or duplex guided compression. Surgical intervention included ligation and explantation of the graft, reconstruction with prosthetic graft or autogenous vein to preserve the inline flow within the native artery.

Patients were explained about their enrolment in the study. There was no randomisation and their treatment plan was not changed from the standard practise. Informed written consent was obtained from the patients. The study was carried out with clearance of the Institute's ethical committee.

INCLUSION CRITERIA

All cases of pseudoaneurysm .

1) Anastomotic pseudoaneurysms
2) Post traumatic
3) Infective
4) Iatrogenic
5) Idiopathic
6) Post AV access related

EXCLUSION CRITERIA

1) Patients with true aneurysms
2) Post stenotic aneurysms
3) Arterial TOS

Diagnosis of pseudoaneurysm was made with history, clinical examination and in selected patients with Duplex Ultrasound and 64 slice CT angiography.

PROCEDURES

Baseline work up

A. History was recorded as per the clinical proforma

B. Physical examination includes

   i. Vital signs – Pulse examination, blood pressure, respiratory rate

   ii. Peripheral pulses examination

   iii. Ankle brachial index in case of lower extremity pseudoaneurysms.

   iv. Venous flow assessment by hand held Doppler

   v. Examination of swelling- pseudoaneurysm

C. Baseline investigations

   i. Complete blood count with platelet count

   ii. Renal function tests

   iii. Blood sugar- RBS/FBS/PPBS

   iv. PT INR

   v. Blood culture

   vi. Chest X Ray

   vii. ECG all leads

   viii. Echocardiography

D. Specific investigations

   i. Duplex USG

   ii. 64 slice computed tomography angiogram in selected patients.

Diagnosis by Duplex USG

Duplex scanning is the preferred diagnostic modality for identification of peripheral or extremity pseudoaneurysm. Indication for testing may include pain, pulsatile mass or bruit at an arterial access site.

Duplex features of pseudoaneurysm include

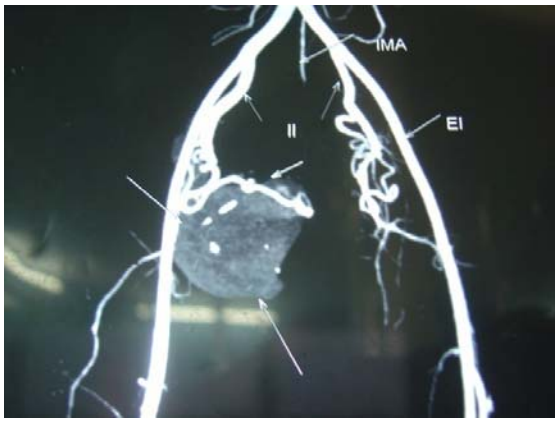
i. Flow outside the artery
ii. Presence of track or stalk from the artery to the aneurysm sac
iii. Characteristic "to- and- fro "flow pattern in the sac corresponding to blood flow in the aneurysm during systole and emptying during diastole. It is called "Ying – Yang" sign.

Duplex USG in a patient who had undergone Aortobifemoral grafting shows pseudoaneurysm at the femoral anastomotic site. Characteristic to and fro motion-"Ying Yang sign" is demonstrated

Arteriovenous fistula

If an arteriovenous fistula is present, a high velocity flow jet (PSV>300cm/sec) between the artery and vein will be identified. Velocity spectra of the inflow artery will show elevated PSV, low resistance flow signal proximal to the arteriovenous fistula and a triphasic (high resistance) signal distally.

CT ANGIOGRAM



CT angiogram in a patient showing Rt Internal iliac artery pseudoaneurysm

CT angiogram in a patient with H/o trauma showing Proximal popliteal pseudoaneurysm with communication with popliteal vein (early filling of venous channels)

Indication for intervention

1) Active bleeding
2) Sudden expansion in size
3) Severe pain
4) Impending rupture
5) Venous compression resulting in edema
6) Neuropathic compression with neuropathic pain
7) Distal ischemia
8) Pseudoaneurysm with AV fistula

Interventions performed were Duplex guided compression or operative intervention.

Duplex guided compression were done in patients with small, superficially located, especially post angiography patients with a narrow neck. Duplex guided compression was performed for 10 min, or till the false lumen thromboses. Post compression duplex will be repeated to see flow within the sac, insitu thrombosis of native artery and distal flow. None of the patients received thrombin injection. Follow up duplex were done at 1 week, 4 weeks and 12 weeks.

Operative interventions included

i. Ligation with evacuation of sac and explantation of the graft
ii. Repair with patchplasty
iii. Reconstruction with autogenous vein
iv. Reconstruction with prosthetic graft
v. Extra anatomical reconstruction
vi. Ligation with delayed reconstruction

Surgical approach

The decision to ligate or revascularize depends on a number of factors

Local

i. Infection-Groin, Foot sepsis
ii. Skin and soft tissue loss
iii. State of the ischemia of the distal extremity
iv. Availability of good inflow, outflow and conduit.

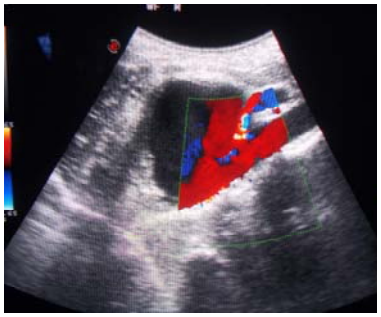
Systemic

i. Hemodynamic status (Most important)
ii. Systemic sepsis
iii. High anaesthetic risk for prolonged procedure
iv. Severe co morbidities(Recent MI, COPD, CKD, Recent CVA)

Operative approach will be to gain proximal control and distal control followed by clamping both proximally and distally. The sac will be opened. Rent in the artery or anastomotic disruption will be seen which will be dealt accordingly. Bleeding points will be ligated within the sac. It is also called Bipolar ligation where both the inflow and outflow arteries are ligated.

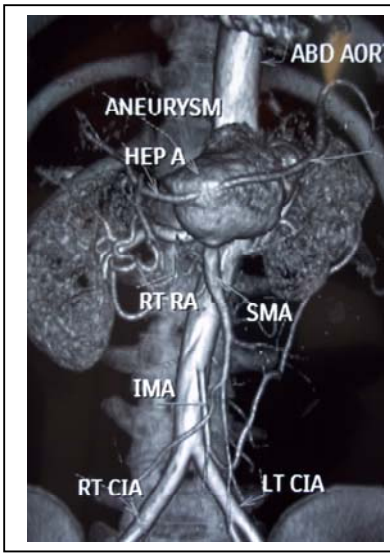
Following reconstruction or ligation the viability of the extremity is assessed. The viability is jeopardised following ligation or unsuccessful revascularization. If the patient has ischemia which has not advanced to irreversible state, those patients can be considered for reconstruction. If the ischemia progresses to muscle and skin necrosis, those patients are better served by early amputation to prevent systemic complications. Few interesting cases will be highlighted subsequently .

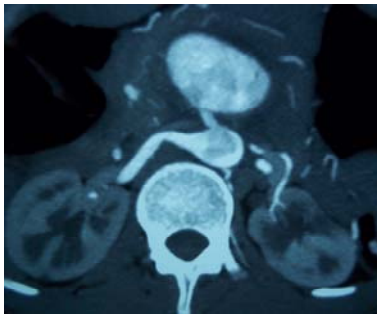
Case 1: 24 yr old patient presented with acute severe abdominal pain radiating to the back. H/o PTFE patch repair for saccular aneurysm of the supra renal aorta was done 6 months earlier. Duplex showed pseudoaneurysm at the patch repair site. CT Angiogram showed pseudoaneurysm to be above the SMA origin. He underwent thoracolaparotomy with arterial bypass from descending thoracic aorta (DTA) to left femoral artery. He underwent bypass from DTA to Infrarenal aorta with ligation of the supra SMA aorta. As the supra SMA aorta was unhealthy, distal anastomosis was done to the infra renal aorta. He recovered well and discharged on day10.



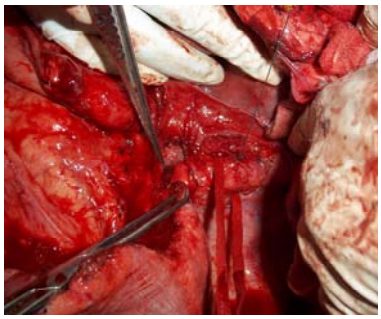
Duplex- Supra SMA Pseudoaneurysm

Angiography- SMA compressed by aneurysm

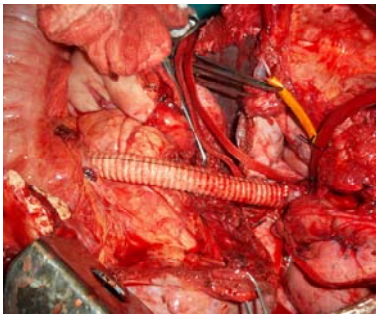




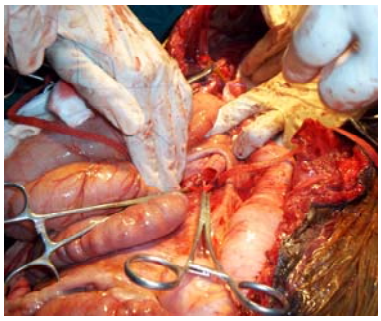
Aorta at level of renal artery- normal



Distal Infrarenal Aorta Control



Completion of Proximal anastomosis

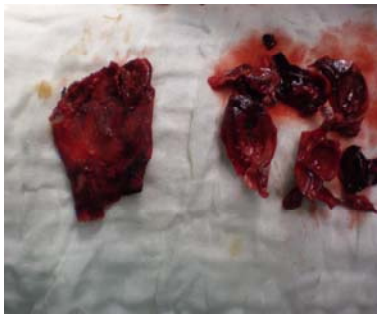


Distal anastomosis- Infrarenal Aorta

Case 2: Patient presented with swelling Lt Iliac fossa following hernioplasty. On evaluation was diagnosed to have EIA pseudoaneurysm. As he had an infected mesh EIA was ligated followed by delayed reconstruction. He underwent Lt CIA to LT CFA PTFE Bypass 3 months later.

EIA control

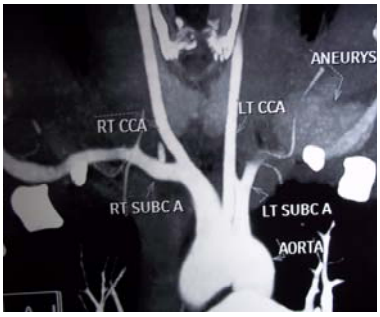
Opened sac



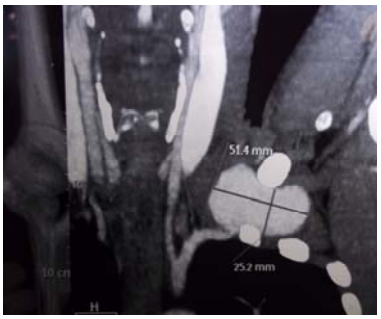
Infected Mesh with Clots

Case 3: 30 yr old gentleman presented with supraclavicular pulsatile swelling post stab injury and radiating pain to lt upper limb. On evaluation was diagnosed to have Lt Subclavian pseudoaneurysm with thrombus close to origin of vertebral artery. He underwent anterolateral thoracotomy for Ist part subclavian control and supraclavicular exploration. He underwent 6mm PTFE interposition graft with excision of pseudoaneurysm. Postoperative period was uneventful.

X ray- B/L Cervical ribs

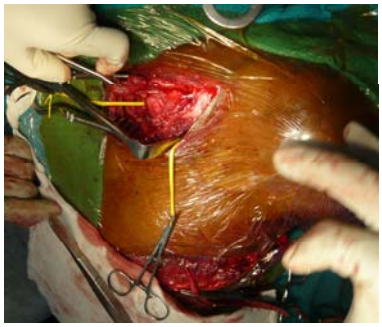


Angio- SCA pseudoaneurysm

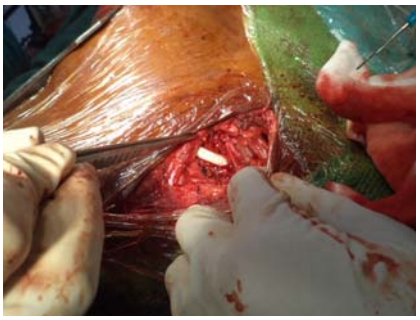


Sac between Clavicle & I rib

Thoracotomy- I part SCA Control



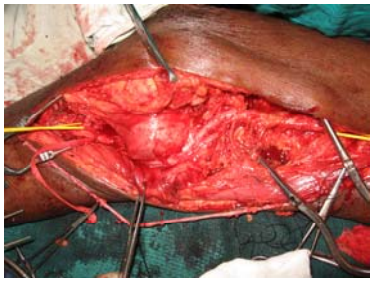
Proximal and Distal control



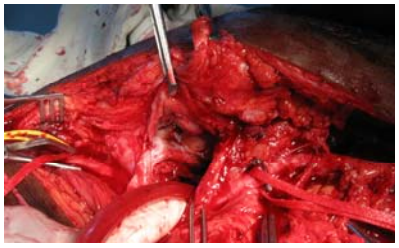
Completed Interposition Graft

Case 4: 55 yr old gentleman presented with swelling in popliteal fossa for past 5 months. H/o External fixator for proximal tibia fracture 10 months back. Distal pulses were absent with ABI-0.5. Duplex showed Popliteal.A pseudoaneurysm with no communication to popliteal vein. He underwent Exploration followed by interposition RSV bypass. Intraoperatively External fixator pin was seen in the sac. He made an eventful postoperative recovery

External fixator with swelling



Pseudoaneurysm of popliteal artery

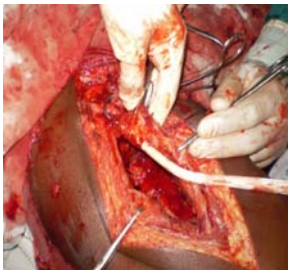


Pin seen within sac

Post op photo

Case 5: 30 yr old gentleman presented with swelling in Rt upper thigh for 15 days associated with pain. History of RTA 40 Days back followed by IM nailing for fracture proximal shaft of femur. On evaluation with duplex was diagnosed to have PFA 2nd part pseudoaneurysm with normal distal pulses. He underwent groin exploration with CFA, PFA, SFA control and opening of aneurysm cavity with ligation of bleeders from within the sac. He had an uneventful recovery.

CFA, SFA &PFA control



Evacuation of Hematoma

Case 6: 17 yr old presented with Iatrogenic Brachial artery pseudoaneurysm following inadvertent puncture during dialysis thru Rt RC fistula. She had symptoms of steal. Under tourniquet she underwent patch repair of brachial artery with preservation of the fistula. Her symptoms of steal subsided and fistula functioned well.

Scar with brachial .A pseudoaneurysm

Vein patch repair

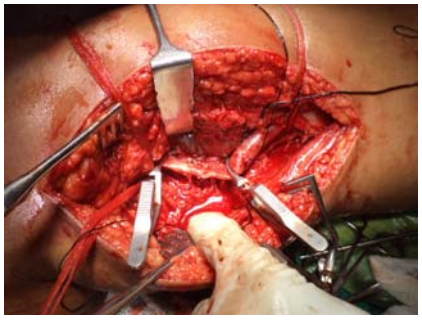
Post op with dilated Cephalic.V

Case 7: 35 yr old presented with nonhealing ulcer Right leg with dilated veins. History of shotgun injury Rt thigh 2 yrs back. On evaluation was diagnosed to have proximal popliteal pseudoaneurysm with communication to popliteal vein. He underwent division of Fistula and primary repair of popliteal artery. He had normal distal pulses postoperatively and ulcer healed after 2 months.

Limb hypertrophy with CVI

Proximal Popliteal Pseudoaneurysm with Avf

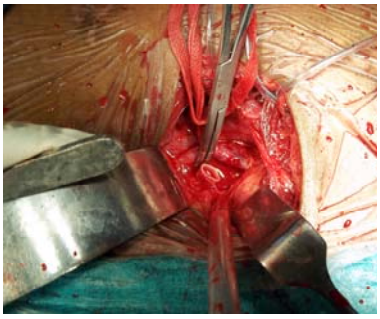
Early filling of Popliteal veins & tributaries



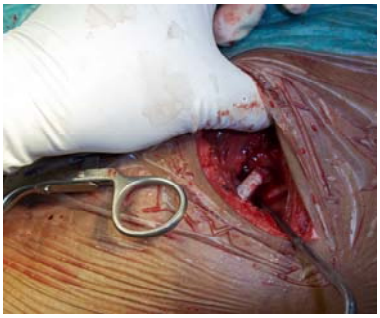
Vein Rent Repaired with rent in Popliteal.A

Case 8: 45 yr old male presented with anastomotic pseudoaneurysm at the femoral region following Aortobifemoral bypass (ABF) 6 months earlier. He underwent a duplex which showed pseudoaneurysm with bilobulation. He underwent extension bypass from Lt Limb of the graft to SFA and ligation of the aneurysm. Postoperatively he had normal distal pulses with an ABI of 1.0.

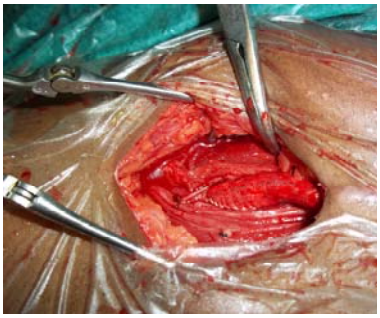
Duplex- Pseudoaneurysm with laminated thrombus



Old Graft Limb In Iliac Fossa



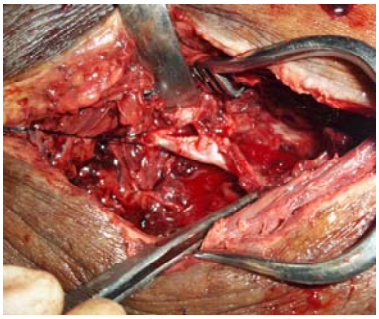
Proximal anastomosis



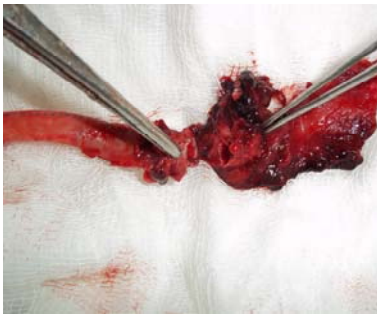
Completed Distal anastomosis

Case 9: 60 yr old diabetic who was operated for Rt Fem pop occlusion with Rt EIA to Proximal popliteal PTFE bypass presented with pseudoaneurysm near proximal popliteal region 2 months later with impending rupture. Duplex showed pseudoaneurysm at the distal anastomotic region. As patient's general condition was not good he was taken for ligation of proximal popliteal artery and explantation of the graft. Intraoperatively sac was seen around the graft to graft anastomosis. Post operatively he developed severe ischemia and underwent Rt Above Knee amputation.

Evacuation of Hematoma after clamping Graft in Groin



Disruption of Distal anastomosis



Graft-graft Sac seen

Analysis Plan

The following variables were assessed in the study

a) Distribution of aetiology

b) Mode of presentation

c) Risk factor distribution

d) Need for intervention

e) Type of intervention- Duplex guided compression or operative intervention

f) Name of the procedure performed

g) Post operative morbidity and mortality

h) Limb salvage rates

i) AV access salvage rates

STATISTICAL ANALYSIS

Non Parametric tests were used for analysis. We used the Pearson Chi-Square test for analyzing the statistical significance between variables. P value < 0.05 was taken as the significance level. Data were analyzed using SPSS 15 (SPSS Inc, Chicago, Ill) for Windows (Microsoft Corp, Redmond, Washington).

Observations and Results

DEMOGRAPHIC DATA:

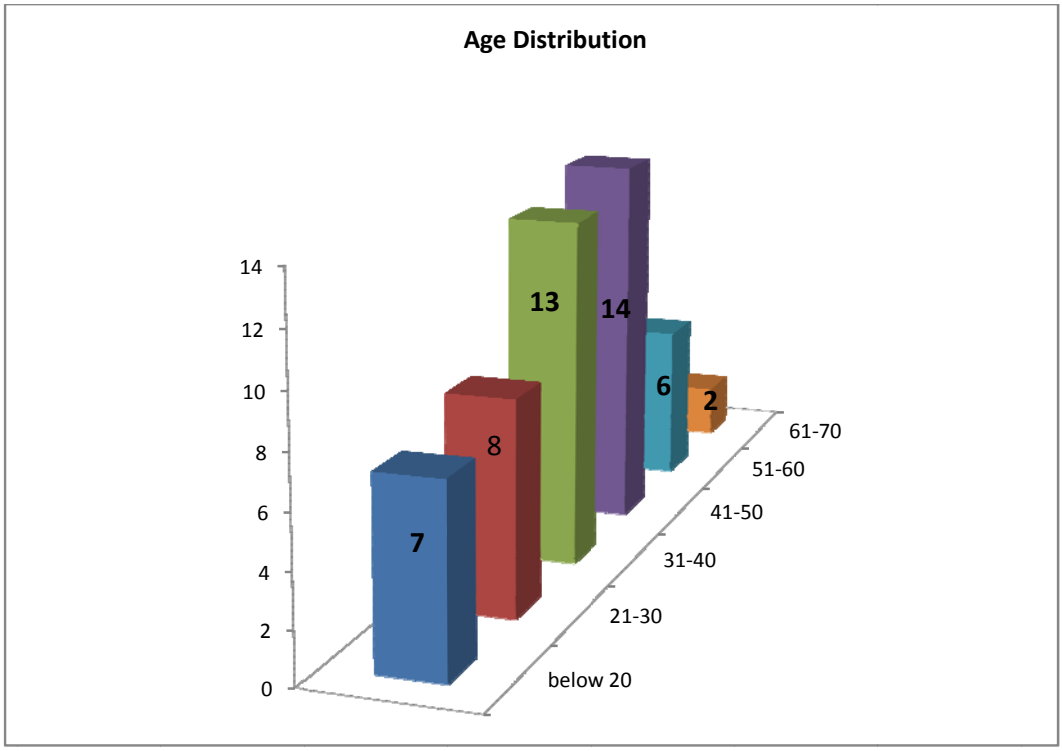
Number of patients studied was fifty (n=50). All patients who presented with pseudoaneurysms to the Department of Vascular surgery were enrolled in the study. The study period was August 2009 to January 2012.

AGE DISTRIBUTION

The mean age ± S.D was 38.84± 13.72 yrs (Range 9-70). Among the 50 patients, 35 patients (70%) were in the age group of 21 -50 yrs.

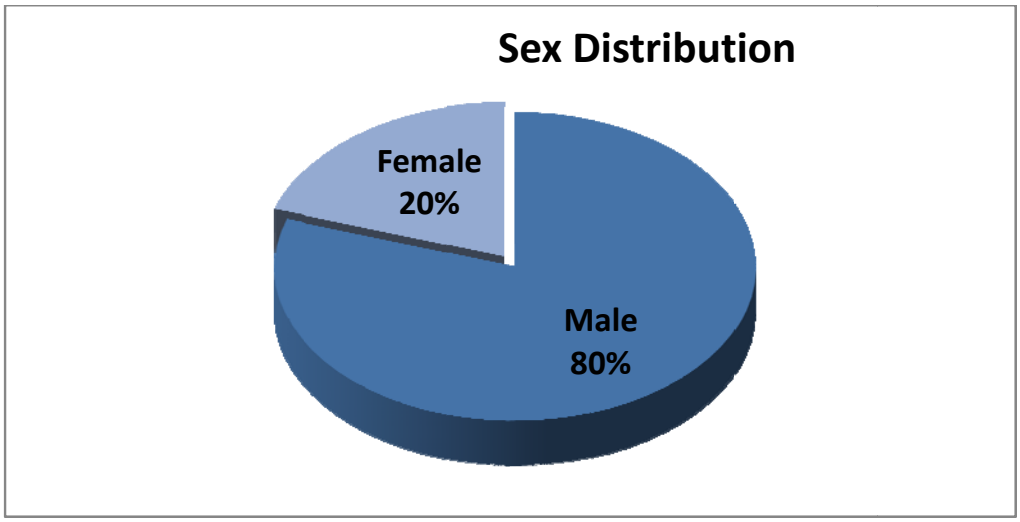
Table 1: Distribution of patients age

Age group (yrs)	<20	21-30	31-40	41-50	51-60	61-70
No (n)	7	8	13	14	6	2
Percentage	14	16	26	28	12	4

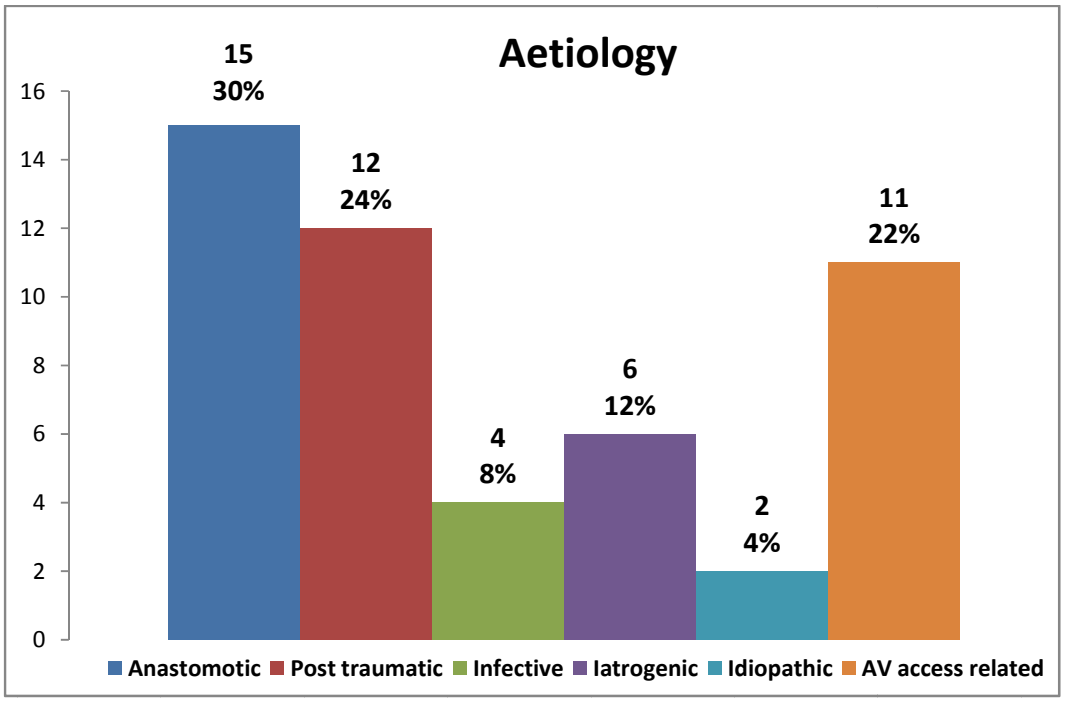


SEX DISTRIBUTION

Among 50 patients, 40(80%) were males and 10(20%) were females.



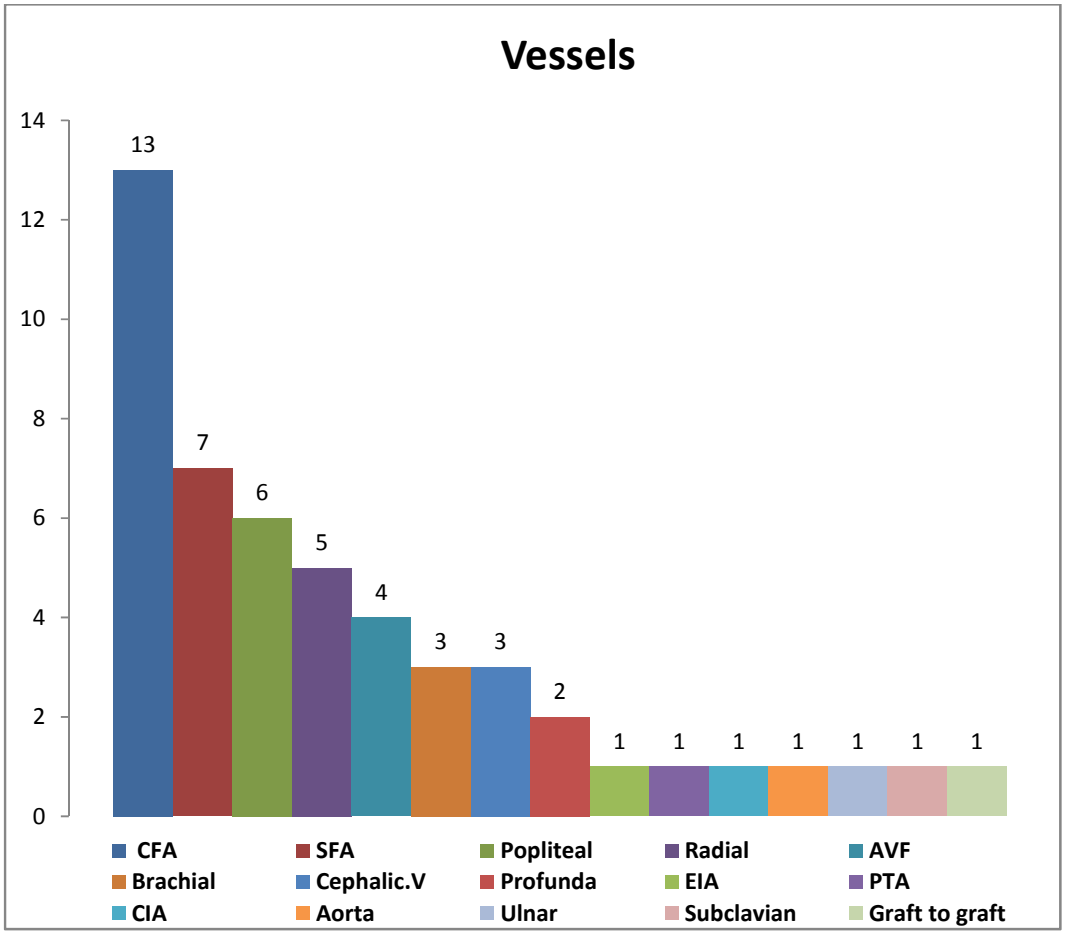
DISTRIBUTION OF AETIOLOGY



Among the 50 patients, 15(30%) had anastomotic and 12(24%) had posttraumatic pseudoaneurysms. The rest were infective 4(8%), iatrogenic 6(12%), idiopathic 2(4%) and AV access related 11(22%) pseudoaneurysms. Anastomotic and post traumatic comprised of more than half (54%) of patients.

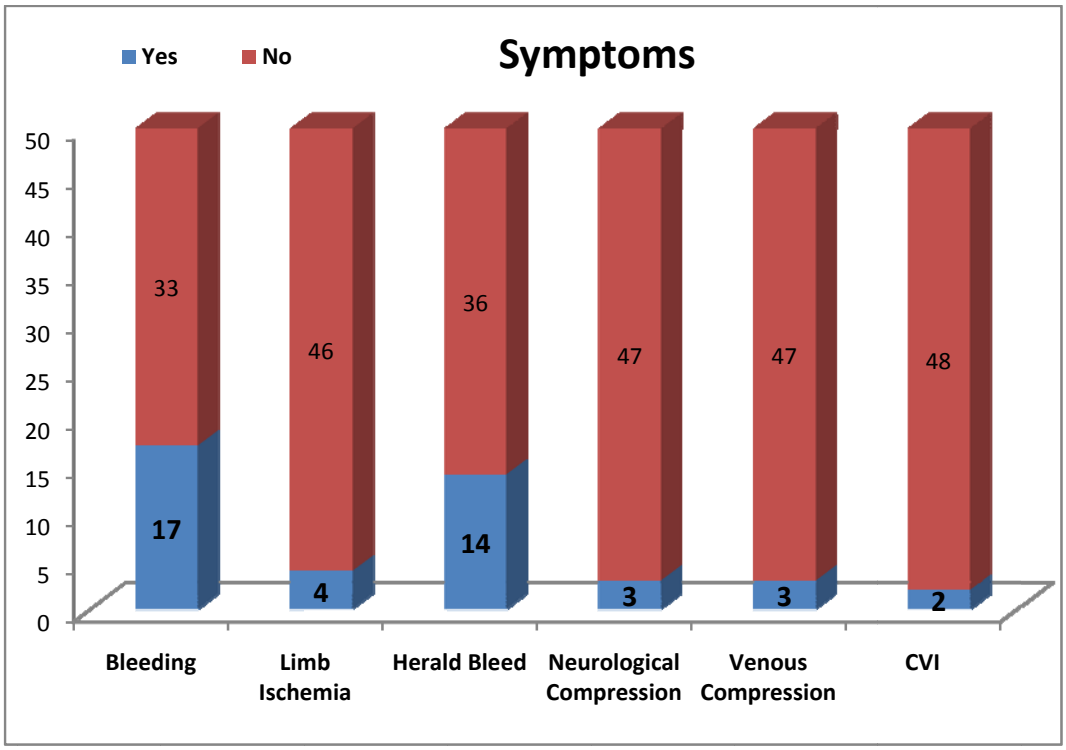
VESSEL INVOLVED

The common femoral artery was the most commonly involved vessel. CFA, SFA, PFA and popliteal together comprises of about 28(56%) of patient group.



DISTRIBUTION OF SYMPTOMS

Among the 50 patients, bleeding was present in 17(34%),herald bleed in 14(28%),limb ischemia in 4(8%),neurologic compression in 3(6%), venous compression in 3(6%)and CVI in 2(4%).Bleeding was the most common presenting symptom.



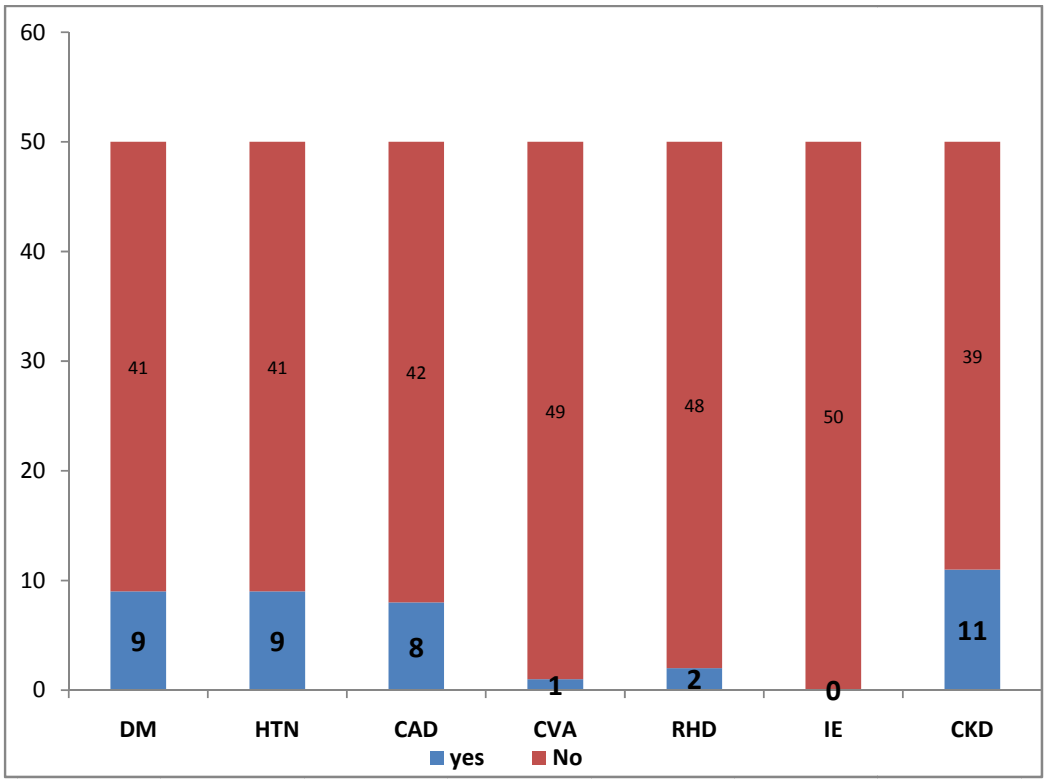
SURGICAL DATA :

Among 50 patients, 33(66%) patients had previous h/o surgery and 16 (32%) patients had previous h/o of trauma.

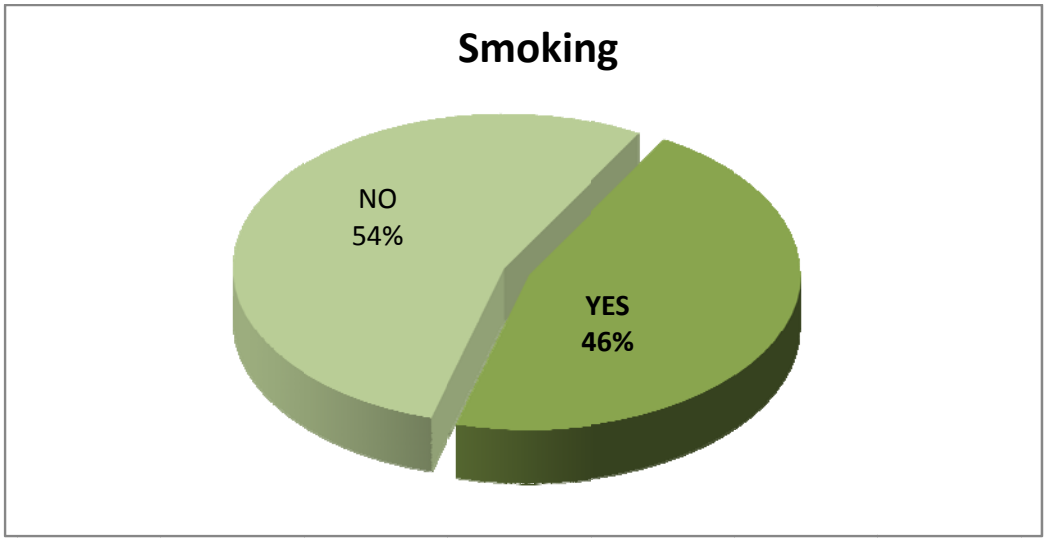
Table 2: Distribution of patients with history of surgery and trauma

	Yes	**No**
H/o Surgery	33(66%)	17(34%)
H/o Trauma	16 (32%)	34(68%)

RISK FACTOR PROFILE

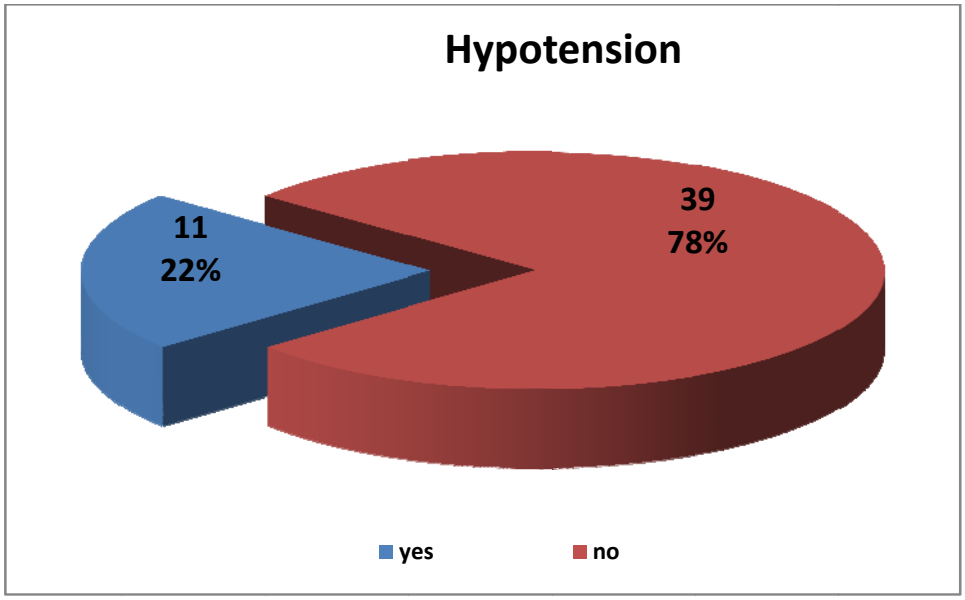


9(18%) of patients had diabetes mellitus and hypertension each. CAD was identified in 8(16%) of patients and CKD was found in 11(22%) of patients. None of the patients were diagnosed with Infective endocarditis. Smoking was found in 23(46%) of patients .Current smoking was found in 14(28%) of patients.

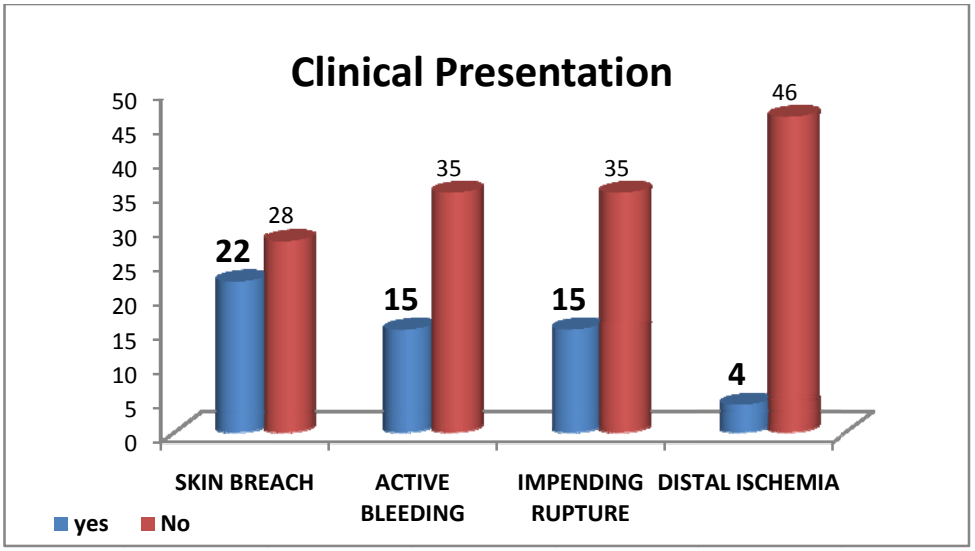


HYPOTENSION AT PRESENTATION

Among 50 patients, hypotension at presentation was identified in 11(22%) of patients.



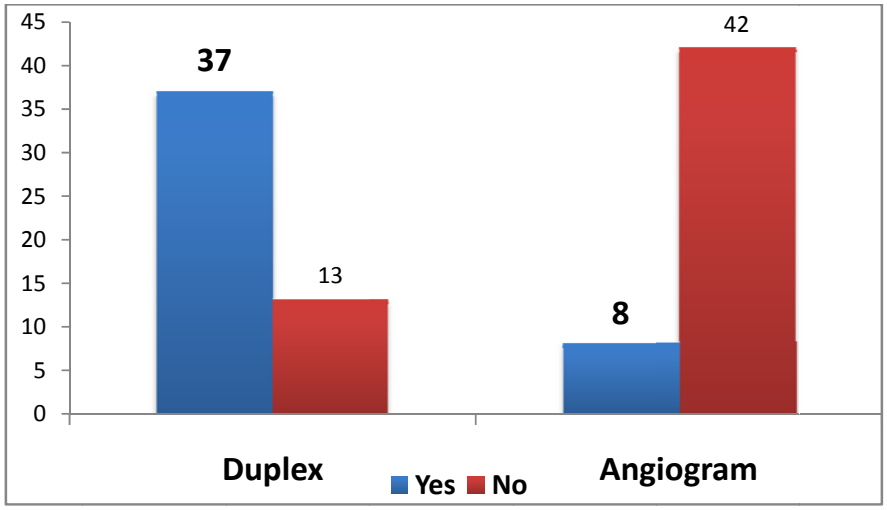
CLINICAL PRESENTATION



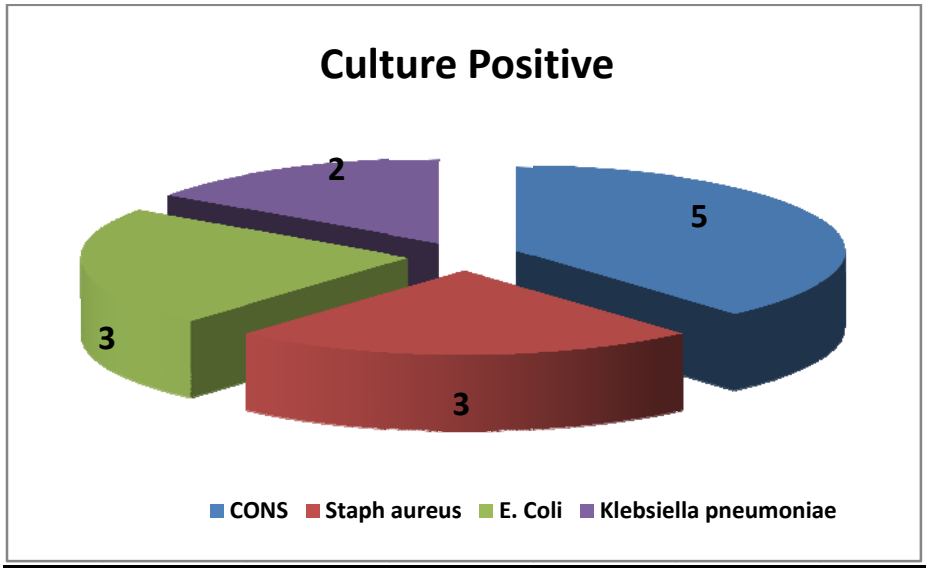
Among the 50 patients, skin breach was found in 22(44%), active bleeding in 15(30%), impending rupture in 15(30%) and distal ischemia in 4(8%) .

IMAGING

Among the 50 patients, Duplex ultrasound was performed in 37(74%) of the patients and CT angiography was done in 8(16%) of the patients.



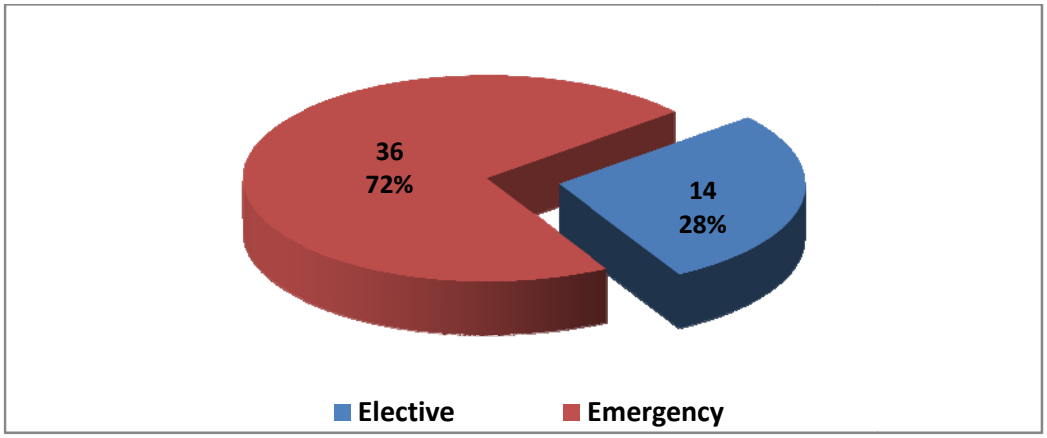
CULTURE



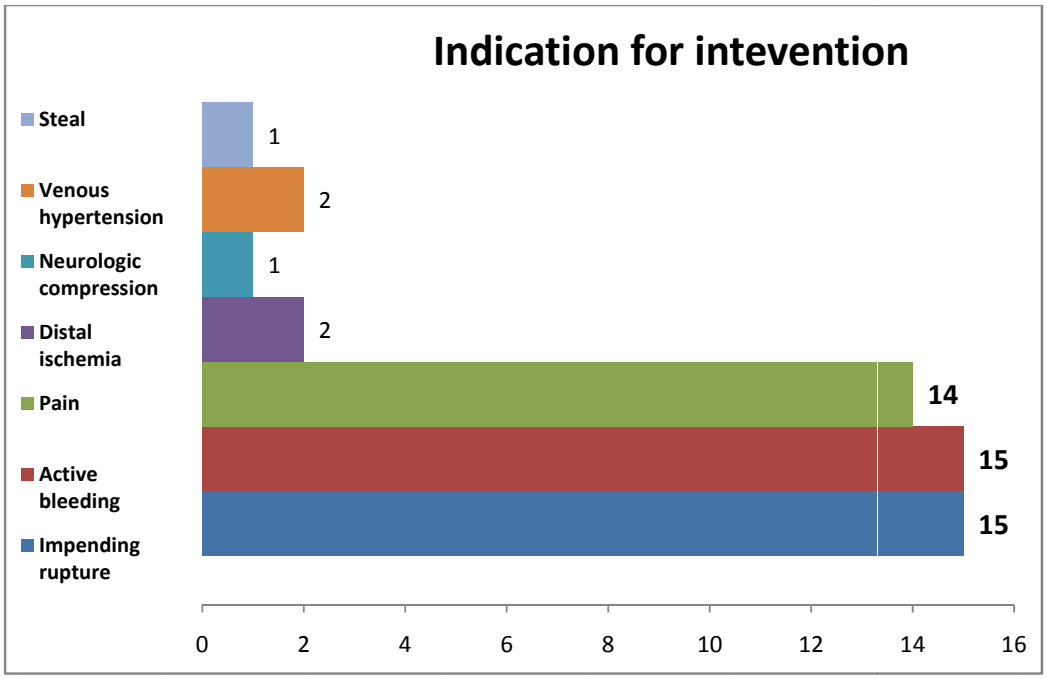
Among 50 patients, positive cultures were identified in 13(26%) of patients. Among them Coagulase negative staphylococci was grown in 5(10%), Staph aureus in 3(6%), E.coli in 3 (6%) and Klebsiella pneumoniae in 2(4%) of patients. Overall staphylococci were the most common organism isolated.

MODE OF PRESENTATION

Among the 50 patients, 36(72%) patients presented as an emergency. Rest 14(28%) patients presented in an elective manner.

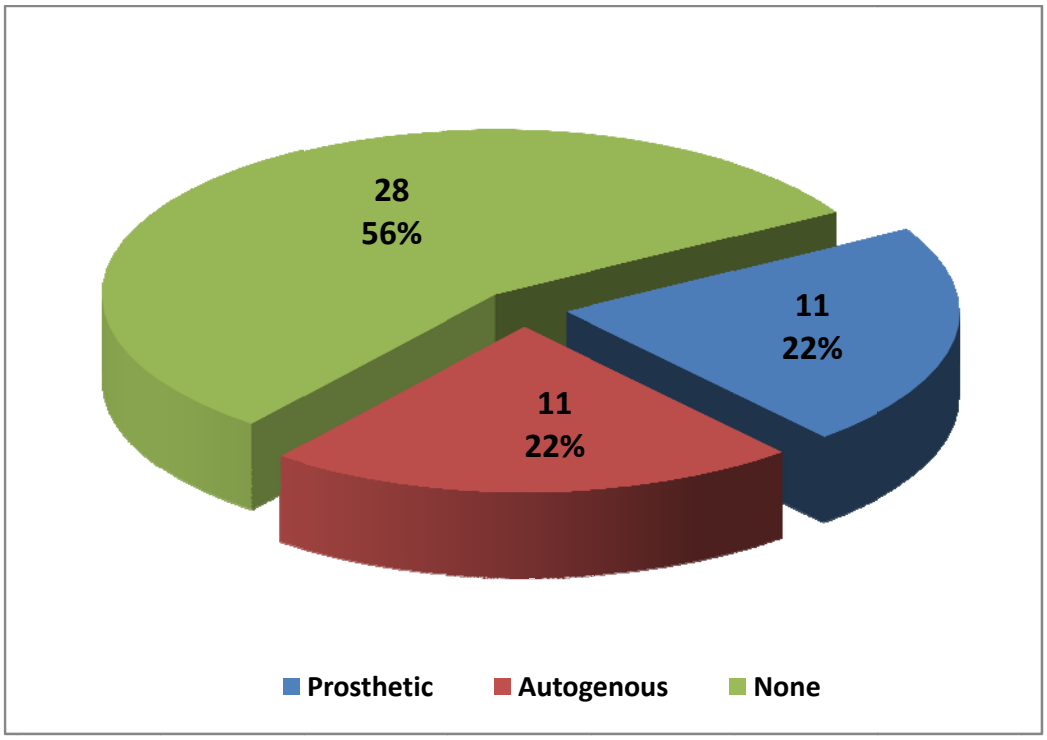


INDICATION FOR INTERVENTION



Among the indications, active bleeding, impending rupture and pain were the commonest indications for intervention. They were present together in 49(98%) of patients. Distal ischemia and venous hypertension secondary to AV fistula were present in 2 (4%) patients each. Steal was found in one patient.

DISTRIBUTION OF CONDUITS



Among the 50 patients, 11(22%) patients had autogenous and another 11(22%) patients had prosthetic grafts. Among the 11 patients with autogenous conduits, 9(18%) belonged to AV access related pseudoaneurysms and only one of the prosthetic group belonged to the AV access related group.

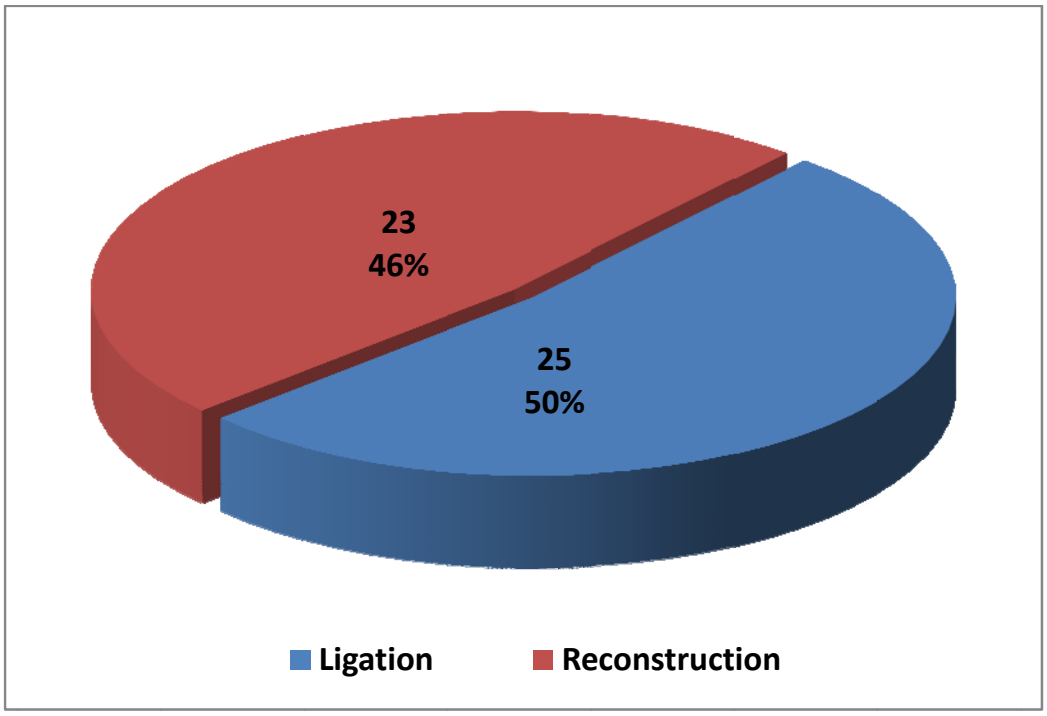
TREATMENT RESULTS

DUPLEX GUIDED COMPRESSION

Among the 50 patients, 2(4%) patients were subjected to Duplex guided compression. They had good outcome. On follow up duplex at 1 month, both had undergone resolution and there were no complications.

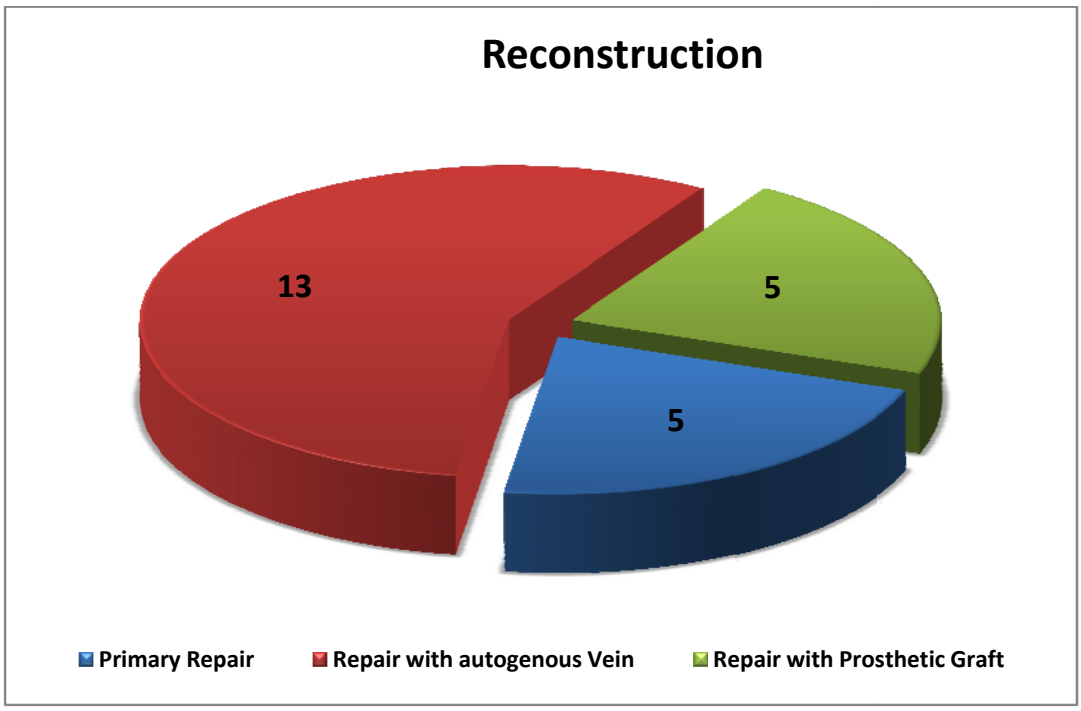
OPERATIVE INTERVENTION

Among the 48 patients, 23(46%) underwent reconstruction and 25(50%) underwent ligation with explantation of the graft. The mean blood loss was 187ml ± 243 ml.



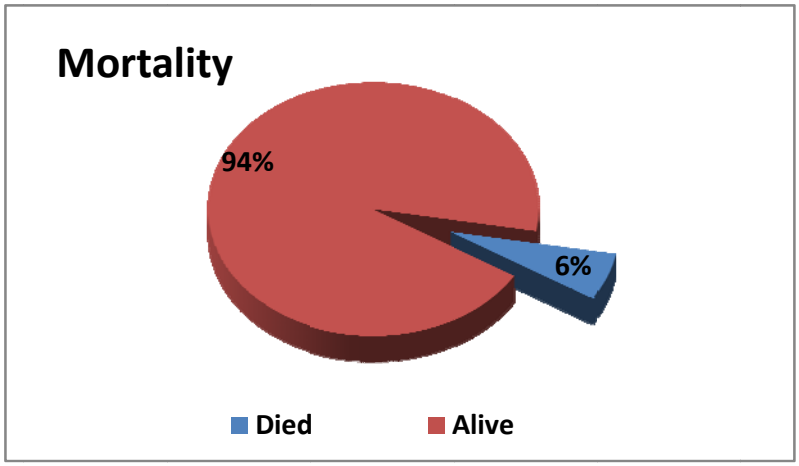
TYPES OF RECONSTRUCTION

Among the 23 patients who underwent reconstruction, 5(10%) underwent primary repair, 13(26%) underwent repair with autogenous vein and 5(10%) underwent repair with prosthetic graft.



OUTCOME ANALYSIS

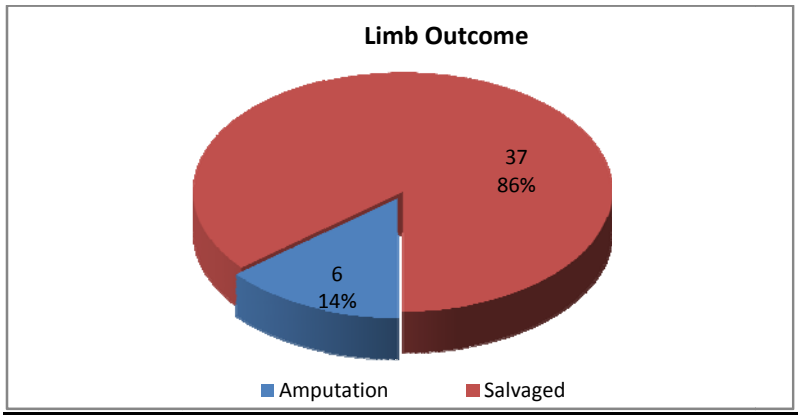
MORTALITY



There were 3 (6%) deaths among the 50 patients. Two of them belonged to the anastomotic group and one belonged to infective group.

LIMB SALVAGE

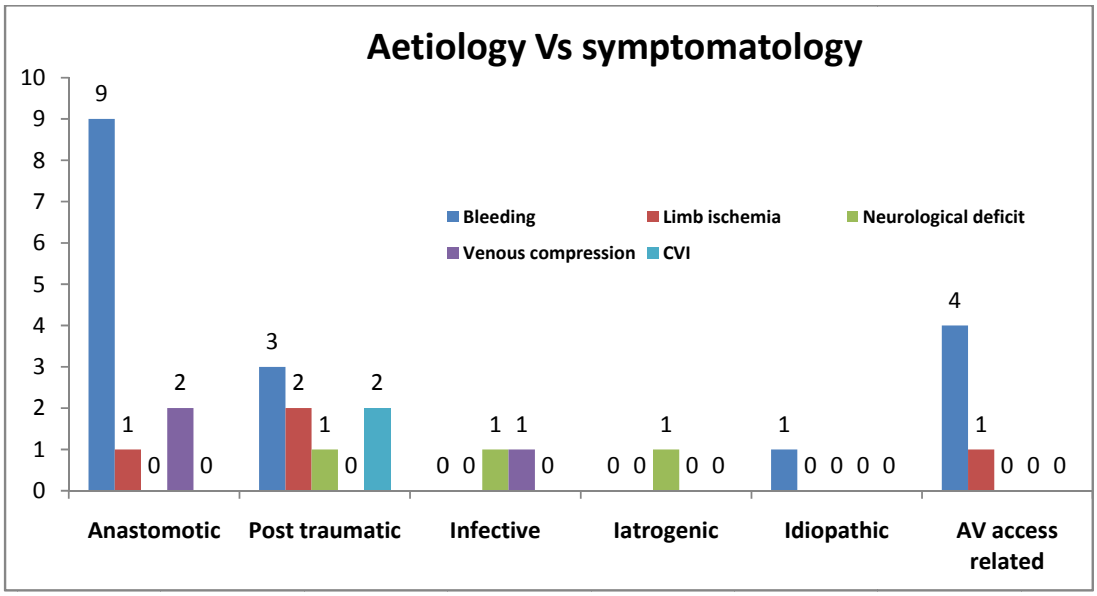
Among the 50 patients, there were 11 patients with AV access related pseudoaneurysms. Among them 4(8%) had pseudoaneurysm at the brachial anstomotic site, whereas the rest 7(14%) had radial or puncture site pseudoaneurysm where there is no threat of limb loss on ligation. Hence deducting those 7(14%) of patients from the total group for limb salvage, 6(14%) patients underwent amputation and the rest 37(86%) patients limbs were salvaged.



SUBGROUP ANALYSIS

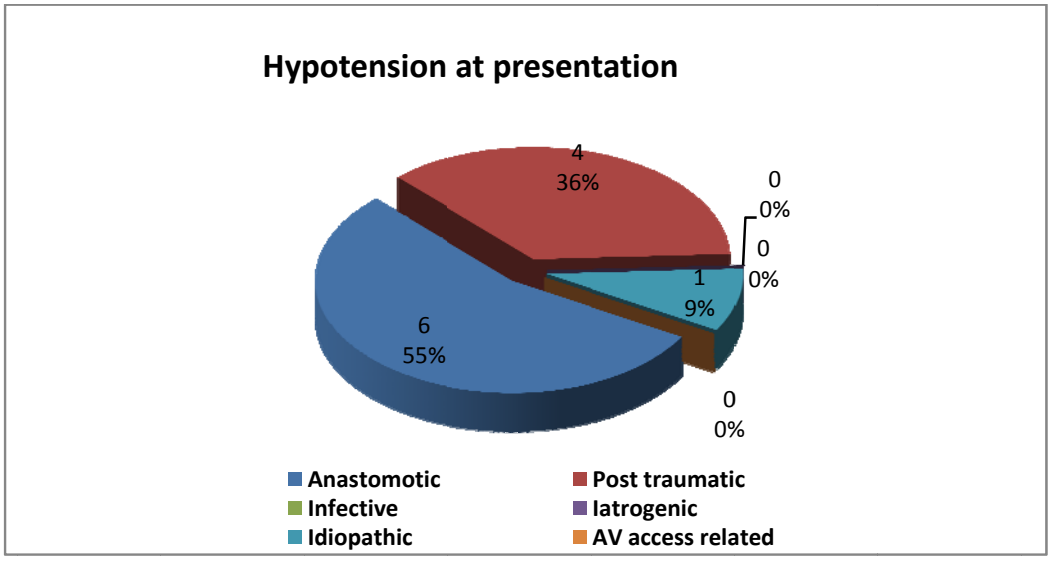
COMPARISON OF AETIOLOGY WITH SYMPTOMATOLOGY

None of the aetiologies had a statistically significant predominance of one symptom. The Pvalue for various symptoms were Bleeding p=0.066, Limb ischemia p=0.803,Neurological compression p=0.339,venous compression p=0.263.



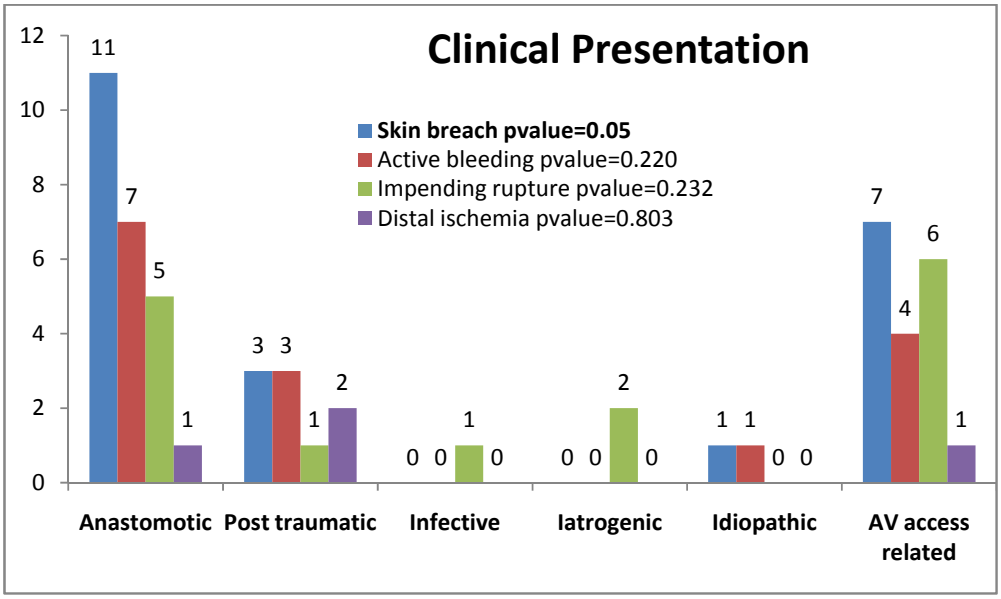
COMPARISON OF AETIOLOGY WITH HYPOTENSION AT PRESENTATION

None of the aetiologies had a bearing on the patients who presented with hypotension. (P value=0.06)

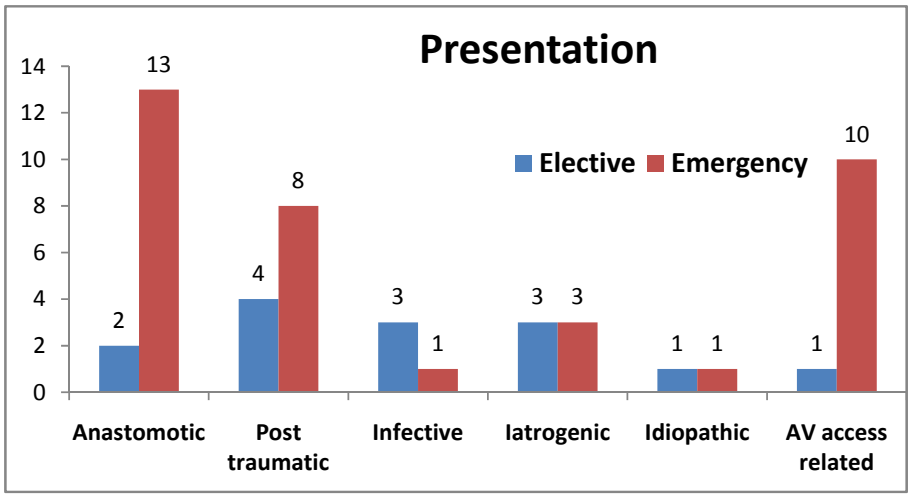


COMPARISON OF AETIOLOGY WITH CLINICAL PRESENTATION

Among the clinical presentation, skin breach was more common in anastomotic and AV access related aneurysms which was statistically significant. Rest were not more common in any of the subgroups.



COMPARISON OF AETIOLOGY TO MODE OF PRESENTATION

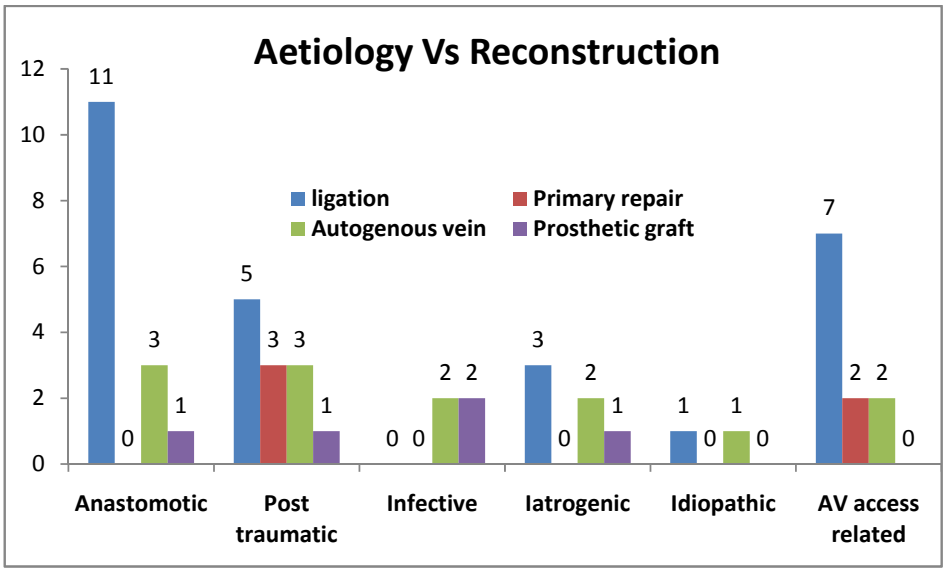


Overall in all the groups, emergency presentation was predominant except in infective group. However aetiology as a variable on the mode of presentation was not statistically significant. (p=0.75).

COMPARISON OF AETIOLOGY WITH INDICATION FOR INTERVENTION

Aetiology as a determinant on the indication for intervention was also not statistically significant (P Value= 0.223)

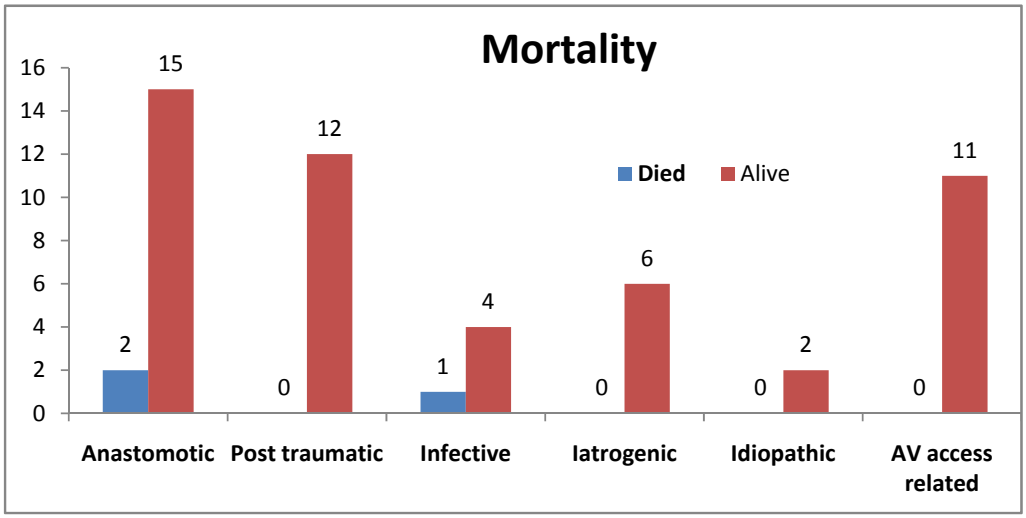
COMPARISON WITH RECONSTRUCTION



There was no statistically significant difference among the various groups in selection of the type of reconstruction. (P value = 0.17). However anastomotic and Av access subgroups underwent ligation most often as the operative intervention.

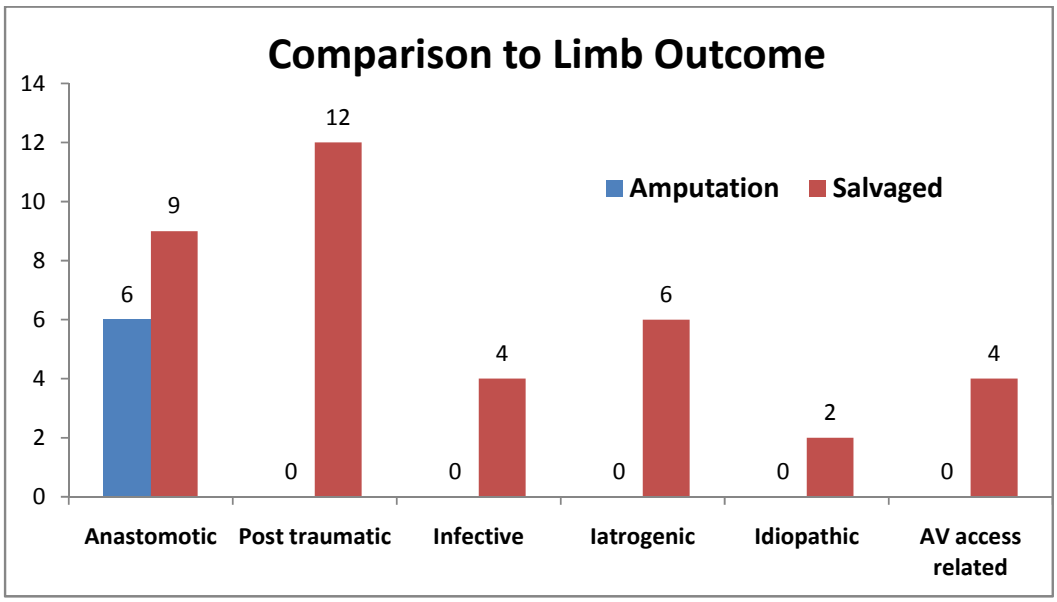
COMPARISON OF AETIOLOGY WITH MORTALITY

Aetiology did not produce a statistically significant difference on mortality (Pvalue=0.309)



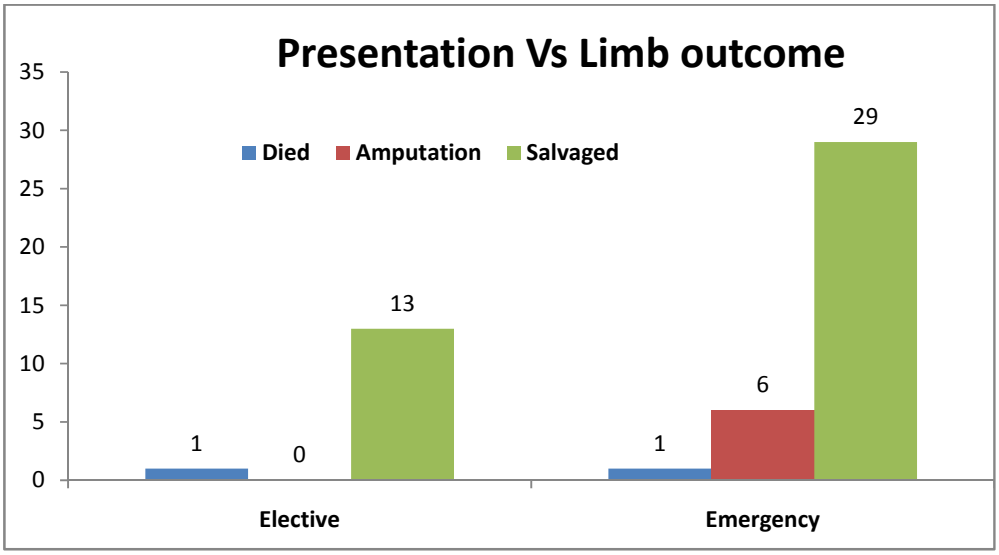
COMPARISON OF AETIOLOGY TO LIMB OUTCOME

Among the various aetiologies, apart from Anastomotic group none of the other groups had any amputation. In the AV access group, 7 patients who had radial and puncture site pseudoaneurysms were not included. When aetiology was considered a variable for limb outcome, P value was statistically significant **(P=0.048)**.



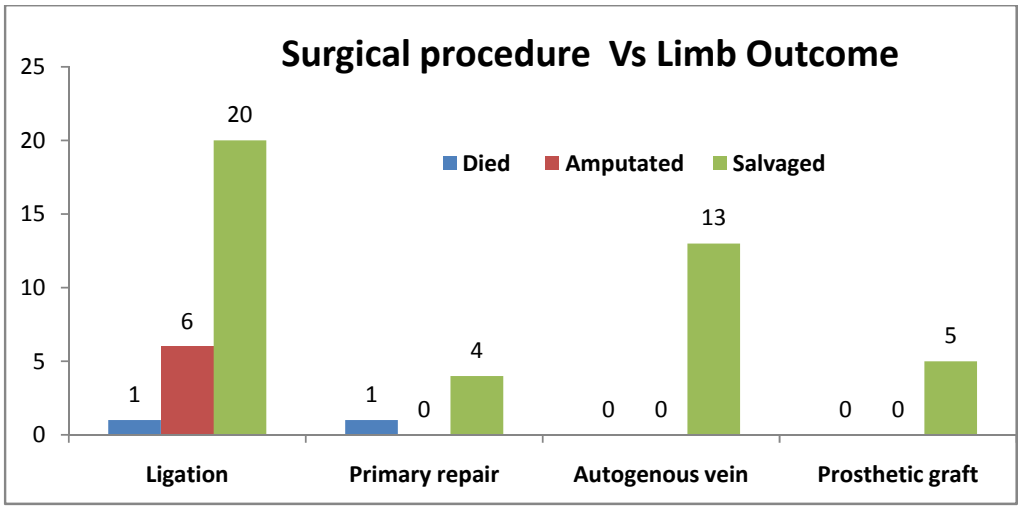
COMPARISON OF THE MODE OF PRESENTATION ON LIMB OUTCOME.

All the amputations performed belonged to the emergency group. None of the patients in the elective group required amputation. However it was not statistically significant (P value = 0.224)



COMPARISON OF THE PROCEDURE PERFORMED WITH LIMB OUTCOME

All 6 patients who underwent amputation belonged to the Ligation group. None of the patients who underwent revascularization underwent amputation. However it was not statistically significant. (P value=0.121)



Discussion

In our study we have evaluated the outcomes and treatment strategies of all patients with pseudoaneurysms presented to the Department of vascular surgery. There were totally 50 patients in our study.

Demographic profile

In literature, the average age of presentation is around 50-60 yrs. In our study, the **mean age ± S.D was 38.84± 13.72 yrs.** The lower mean age is due to a significant number of post traumatic pseudoaneurysms and relatively younger age of PAD presentation in our population. The majority of pseudoaneurysms reported in the modern day literature are following diagnostic angiography or following endovascular procedures, who present in the 6^{th} or 7^{th} decade. Hence is the difference in the age group.

In our study group **40(80%) were males** and 10(20%) were females. The higher prevalence of PAD among males and higher prevalence of trauma among males explains the male preponderance in our study.

Among the various aetiologies, anastomotic **15(30%) and posttraumatic 12(24%) pseudoaneurysms were more common**. They together comprised about more than half (54%) of patients. In a study by Zhu Xiao-li et al, in about 55 patients with pseudoaneurysms the aetiology was trauma (33/55), infection (5/55), iatrogenic (6/55), and idiopathic (11/55). However in literature majority of the pseudoaneurysms are following percutaneous catheter based interventions. Due to the development of technology and experience, more and more diagnostic and interventional catheterization procedures are performed on a daily basis. Hence is an increased prevalence of pseudoaneurysms in this subset of patients.

Among the various vessels involved, femoral artery especially common femoral artery is the most common site of pseudoaneurysms. In our study also, **common femoral artery was the most commonly involved vessel**. CFA, SFA, PFA and popliteal together comprises of about 28(56%) of patient group.

Patient characteristics, their presenting symptoms, co morbidities and their clinical presentation are listed in the table. Among the symptoms, bleeding was the most common symptom. None of the aetiologies had a statistically significant predominance of one symptom. Apart from bleeding, there were 4 patients with limb ischemia. Two of them belonged to the post traumatic group, while the rest two belonged to the anastomotic and the AV access groups each.

One in the AV access group had limb ischemia secondary to steal. She had a pseudoaneurysm following inadvertent puncture of the brachial artery during dialysis through Rt radiocephalic fistula. As she had a distally functioning AV fistula with brachial.A pseudoaneurysm with thrombus, she had symptoms of steal. On occluding the fistula her pain got relieved and flow improved in the radial.A and palmar arch. She was subjected to vein patch repair for the pseudoaneurysm under tourniquet.

Among the 3 patients with neurogenic compression, one belonged to post traumatic, iatrogenic and infective group each. Both the patients with venous hypertension belonged to the post traumatic group and both had communication to the vein (Traumatic AVF). In patients who had venous compression, one belonged to anastomotic and infective group each.

Table 3: Patient characteristics

S no	Characteristics		No(percentage)
A	Symptoms	Bleeding	17(34%)
		Limb ischemia	4(8%)
		Herald bleed	14(28%)
		Venous compression	3(6%)
		Chronic venous insufficiency	2(4%)
		Neurologic compression	3(6%)
B	Co morbidities	Diabetes mellitus	9(18%)
		Hypertension	9(18%)
		CAD	8(16%)
		CVA	1(2%)
		CKD	11(22%)
		RHD	2(4%)
C	Surgical H/O	H/o surgery	33(66%)
		H/o trauma	16 (32%)
D	Personal H/o	Smoking	23(46%)
		Current smoking	14(28%)
E		H/O conventional angiogram	3(6%)
F		Hypotension at presentation	11(22%)
G	Clinical presentation	Skin breach	22(44%)
		Active bleeding	15(30%)
		Impending rupture	15(30%)
		Distal ischemia	4(8%)

.

Among the co morbidities DM, HTN were observed in 9(18%) each, whereas the literature has a higher prevalence (40%) of these co morbidities. This is because of the variation in the aetiology of our patients. CKD was identified in 11(22%) of patients and all of those had AV access related pseudoaneurysms. Smoking was found in 23(46%) of patients and current smoking was found in 14(28%) of patients.

With respect to anastomotic aneurysms, multivariate analysis showed chronic obstructive pulmonary disease, current smoking, and postoperative wound infection to be major contributors to the development of primary and recurrent anastomotic femoral pseudoaneurysms.

There are a significant number of patients with infected femoral artery pseudoaneurysms who are intravenous drug abusers. And in that subset of patients it has been found ligation alone is a safer procedure than prosthetic reconstruction, because of the risk of usage of those grafts for drug abuse. However we didn't have any of our patients with drug addiction.

There were 11(22%) patients who presented to the emergency with history of active bleeding and hypotension. When hypotension was compared with various subgroups, none of the subgroups had a statistically significant influence on patients presenting with hypotension. There are no available data on the prevalence of hypotension among patients who present with pseudoaneurysms.

Coming to the clinical presentation, skin breach was found in 22(44%), active bleeding in 15(30%), impending rupture in 15(30%) and distal ischemia in 4(8%). Comparing the various aetiologies, **skin breach was more common with anastomotic and AV access group and it was statistically significant (P value=0.05)**. The rest were not significant. In majority of the studies, clinical presentation has been an asymptomatic swelling.

Coming to the diagnostic evaluation, Duplex ultrasound was performed in 37(74%) of the patients and CT angiography was done in 8(16%) of the patients. Any patient without active bleeding or hypotension was subjected to Duplex ultrasound. CT angiography was performed in those patients where additional anatomical information was required. All the eight patients who underwent CTA had an elective presentation.

In literature regarding the microbiological analysis, streptococcus and staphylococcus together comprised about 40% of infected aneurysms. In our study blood culture was positive in only one patient. With respect to clot or graft culture, **positive cultures were identified in 13(26%) of patients**. Among them Coagulase negative staphylococci were grown in 5(10%), Staph aureus in 3(6%), E.coli in 3 (6%) and Klebsiella pneumoniae in 2(4%) of patients. Overall **staphylococcus was the commonest organism isolated** in our study group. Among the subgroups, culture was most often isolated in anastomotic aneurysms but was not statistically significant. When infection is the cause for anastomotic pseudoaneurysm, the duration of presentation from the index procedure is shortened.

In the literature, the majority around 70- 80% of cases had an elective presentation. We had a different pattern. 14 (28%) had an elective presentation whereas the rest **36(72%) had presented as an emergency** with active bleeding or impending rupture. Aetiology didn't have a bearing on the mode of presentation.

With regard to the indication for intervention active bleeding, impending rupture and pain were the commonest indications for intervention. Aetiology did not influence on the indication for intervention in a statistically significant manner.

PROCEDURAL CHARACTERISTICS :

Among the therapeutic options, Duplex guided compression was done for 2(4%) of patients. Rest of the patients underwent operative intervention. The increased incidence of skin breach, active bleeding and impending rupture explains the less usage of duplex guided compression as the treatment option. They together were present in 49(98%) of patients. Hence is the need for operative intervention in the majority of the patients.

Ultrasound-guided thrombin injection is currently the method of choice in many centres. Thrombin (factor IIa) converts the precursor fibrinogen to active fibrin. Fibrin is then cross-linked by factor XIIIa in the presence of calcium leading to the formation of thrombus. Both bovine and human preparations are available. Contraindications to this technique include pseudoaneurysm complicated by peripheral or cutaneous ischemia, infection or in those with surgical grafts. Pseudoaneurysms arising above the inguinal ligament are also avoided due to the potential risk of rupture and uncontrollable bleeding.

No endovascular interventions were performed in any of the patients. All were subjected to operative intervention either ligation or reconstruction. Ligation was performed in 25(50%) of patients and reconstruction was performed in the rest 23(46%) of the patients. Among the reconstructive procedures, (10%) underwent primary repair, 13(26%) underwent repair with autogenous vein and 5(10%) underwent repair with prosthetic graft. On comparison of the various subgroups, none of them had a statistically significant bearing on the operative intervention. Although ligation was most commonly performed in anastomotic and AV access related

pseudoaneurysms. There are no available data on various methods of reconstruction in various subgroups of pseudoaneurysms and their outcome.

Among the 50 patients, 11(22%) patients had autogenous and another 11(22%) patients had prosthetic grafts. Among the 11 patients with autogenous conduits, 9(18%) belonged to AV access related pseudoaneurysms and only one of the prosthetic group belonged to the AV Access related group. Since these patients with CKD have decreased immunity and moreover on dialysis catheters, they are more prone for infection. Hence this **comparison of autogenous Vs prosthetic conduits might not hold good, unless compared for the same subset of patients**. The literature also supports that there is increased incidence of pseudoaneurysms with prosthetic grafts compared to autogenous grafts.

OUTCOME ANALYSIS

MORTALITY

There were 3 (6%) deaths among the 50 patients. Two of them belonged to the anastomotic group and one belonged to infective group. Among the anastomotic group, one patient died on day 0 due to acute myocardial infarction and the other died due to sepsis. The one with infective aetiology had an aortic pseudoaneurysm for which he was operated, presented 6 months later with free rupture and died of hemorrhagic shock. None of the aetiologies had a statistically significant influence on mortality.

SYMPTOM RELIEF

In all the 17 patients who presented with bleeding, bleeding was controlled. None of the patients died of hemorrhagic shock intraoperatively. Among the 4 patients who presented with limb ischemia, one patient who belonged to the anastomotic group required amputation. In rest 3 patients limbs were salvaged. All three patients with neurogenic compression had relief of pain postoperatively.

In the three patients who presented with venous compression, two had undergone amputation, although for different reasons. Both of them belonged to anastomotic group. Two patients who had traumatic AVF had relief of venous hypertension dramatically postoperatively.

LIMB SALVAGE

Among the 50 patients, there were 11 patients with AV access related pseudoaneurysms. Among them 4 had pseudoaneurysm at the brachial anastomotic site, whereas the rest 7 had radial or puncture site pseudoaneurysm where there is no threat of limb loss on ligation. Hence deducting those 7 patients from the total group 43 patients were taken for assessment of limb salvage. Among the 43 patients, **6(14%) underwent amputation and in the rest 37(86%) limb salvage was achieved**.

All six patients who underwent amputation belonged to the anastomotic group. Aetiology was **statistically significant** when considered a variable for limb outcome **(P value=0.048**). All the patients who underwent amputation had undergone the primary surgery for occlusive arterial disease with incapacitating Claudication or critical limb ischemia. The higher preponderance for anastomotic group going for amputation could be explained by the presence of severe distal disease and poor collateralisation. Therefore **there is a higher risk of limb loss in patients presenting with anastomotic aneurysms especially operated for occlusive arterial disease**.

In our study group all those patients who underwent amputation belonged to the emergency group. There is a higher risk for limb loss when patient presents as an emergency, however it is not statistically significant (P value=0.224). **When ligation was considered a treatment option there was a higher chance for limb loss**, but not statistically significant (P value=0.121).

In the six patients who underwent amputation, **CFA was ligated in 4 patients** and popliteal artery in rest 2 patients. This could be explained by the fact that there is always a higher risk of limb loss when CFA is ligated compared to SFA, because the PFA perfusion is also compromised in the former.

AVF SALVAGE RATE

Out of the 11 patients with AV access related pseudoaneurysms, **AVF salvage was achieved only in two patients (18%)**. One was a puncture site pseudoaneurysm and the other was brachial artery pseudoaneurysm following inadvertent brachial artery puncture during dialysis. The rest of the patients presented either with active bleeding or skin breach, with hypotension and sepsis. Therefore salvage could not be attempted.

Treatment for haemodialysis access aneurysms and pseudoaneurysms include open surgical and percutaneous techniques. Until recently, the standard therapy for aneurysms was open surgical repair with excision or ligation of the pseudoaneurysm,

followed by interposition grafting with a prosthetic conduit. Open surgery typically is performed in cases of access rupture and infection. Percutaneous treatments are intended to maintain patency and function of the existing access while excluding the aneurysm or pseudoaneurysm from the circulation. Percutaneous treatments include endovascular stent or covered stent implantation, coil embolization, and ultrasound-guided thrombin injection. The most appropriate treatment must be selected according to the cause, location, size, and accessibility of the pseudoaneurysm.

Pseudoaneurysm is not rare, and various conditions can cause a pseudoaneurysm within the cardiovascular system. With the introduction of modern imaging modalities, the diagnosis of pseudoaneurysm has become more common, and the assessment of morphologic features, rupture risk and expendability of the donor artery has become easier. This information is essential for proper treatment planning. A reasonable selection of treatment strategies tailored to the individual patient is essential for good prognosis.

Summary and Conclusions

We summarize from our study that

i. Our patients had a younger age of presentation. Mean age was 39 years.

ii. Anastomotic 15(30%) and posttraumatic 12(24%) pseudoaneurysms were more common in our study population. They together comprised about more than half (54%) of patients.

iii. Common femoral artery was the most commonly involved vessel. The lower extremity arteries together comprised about 28(56%) of patients.

iv. 11(22%) of patients presented with hypotension

v. Skin breach was most common in anastomotic and AV access related pseudoaneurysms and was statistically significant.

vi. 36(72%) of patients needed emergency intervention.

vii. The most common indications for intervention were active bleeding, impending rupture and pain.

viii. Culture was positive in 13 (26%) of patients. Staphylococcus was the most commonly isolated organism. It was more often isolated in anastomotic group but was not significant

ix. Duplex guided compression was performed successfully in 2(4%) of patients. Both of them were post angiography with small, superficial pseudoaneurysm and short neck.

x. Ligation was performed in 25(50%) and reconstruction performed in 23(46%) of patients.

xi. Mortality was 6% in the study group and was common in the anastomotic group.

xii. Limb salvage rate was 86% and amputation rate was 14%.

xiii. Amputation was more common in the Anastomotic subgroup (p =0.048) because of distal occlusive disease and poor collateralisation.

xiv. Amputation was more common when ligation was performed as a therapeutic option. But it was not significant(p =0.121)

xv. AVF salvage rates were low (18%) because more number of patients presented with bleeding, skin breach, hypotension and sepsis.

xvi. Overall, Anastomotic pseudoaneurysms had a poorer prognosis in terms of increased amputation rates and lower limb salvage rates. This was statistically significant.

Bibliography

1. Rutherford's textbook of Vascular Surgery. Cronenwett and Johnston- 7th Edition.
2. *F. Ahmad, S.A. Turnery, P. Torrie, M. Gibson.* Iatrogenic femoral artery pseudoaneurysms -A review of current methods of diagnosis and treatment Clinical Radiology (2008) 63, 1310-1316
3. *Botdos Toursarkissian, Brent T. Allen, Drazen Petrinec*. Spontaneous closure of selected iatrogenic pseudoaneurysms and arteriovenous fistulae. J Vase Surg 1997;25:803-9.
4. *Kari Ylo¨nen., Fausto Biancari, Enrico Leo* . Predictors of development of anastomotic femoral pseudoaneurysms after aortobifemoral reconstruction for abdominal aortic aneurysm. The American Journal of Surgery 187 (2004) 83–87
5. *Mehmet Ates,a Sinan Sahin,b Cuneyt Konuralp***.** Evaluation of risk factors associated with femoral pseudoaneurysms after cardiac catheterization. J Vasc Surg 2006;43:520-4.
6. *Douglas B. Hood , Mark A. Mattos, Michael G. Douglas*. Determinants of success of color-flow duplex-guided compression repair of femoral pseudoaneurysms Surgery 1996;120:585-90.)
7. *Patrick A. Stone, Ali F. AbuRahma,, and Sarah K. Flaherty* . Reducing duplex examinations in patients with iatrogenic pseudoaneurysms J Vasc Surg 2006;43:1211-5
8. *Michael Khoury, Alanna Rebecca, ILathleen* Duplex scanning-guided thrombin injection for the treatment of iatrogenic pseudoaneurysms. J Vasc Surg 2002;35:517-21.

9. *Sergi Bellmunt, Jaume Dilmé, Antonio Barros*. Compression assisted by removable coils as a new treatment for iatrogenic femoral pseudoaneurysms J Vasc Surg 2010

10. *Christopher L Bell, Ahsan T Ali, John G Brawley*. Arterial Reconstruction of Infected Femoral Artery Pseudoaneurysms Using Superficial Femoral-Popliteal Vein J Am Coll Surg 2005;200: 831–836.

11. *Ha-Hun Song, Yoo-Dong Won,and Young-Joo Kim*. Transcatheter N-butyl Cyanoacrylate Embolization of Pseudoaneurysms. J Vasc Interv Radiol 2010**;** 21:1508–1511

12. *Annie Wang, and James E. Silberzweig*. Brachial Artery Pseudoaneurysms Caused by Inadvertent Hemodialysis Access Needle Punctures *American Journal of Kidney Diseases,* Vol 53, No 2 (February), 2009: pp 351-354.

13. *Luis Bechara-Zamudio, Guillermo Olivé, Héctor Barone.* Traumatic abdominal aortic pseudoaneurysm treated with balloonexpandable bifurcated endoprosthesis. J Vasc Surg 1998;28:345-8.

14. *Geert Maleux*, *Didier Bielen*, *Sam Heye.* Translumbar thrombin embolization of an aortic pseudoaneurysm complicating lumbar disk surgery. J Vasc Surg 2005;42:163-7

15. *Vito Giovanni Ruggieri, Romain Malezieux, Najeebullah Bina.* Hybrid treatment of an ascending aortic pseudoaneurysm following multiple sternotomies. J Vasc Surg 2010; 51:729-31.

16. *Donald T. Baril, Sharif H. Ellozy, Alfio Carroccio*. Endovascular repair of an infected carotid artery Pseudoaneurysm J Vasc Surg 2004;40:1024-7

17. *Claus G. Schneider, Helmut Kortmann, Hamburg.* Pseudoaneurysm of the common carotid artery due to ongoing trauma from the hyoid bone J Vasc Surg 2007;45:186-7

18. *Chiau-Suong Liau, Feng-Ming Ho, Ming-Fong Chen*. Treatment of iatrogenic femoral artery pseudoaneurysm with percutaneous thrombin injection J Vase Surg 1997;26:18-23.

19. *Chris Klonaris, Athanasios Katsargyris, Anastasios Papapetrou*. Infected femoral artery pseudoaneurysm in drug addicts: The beneficial use of the internal iliac artery for arterial reconstruction J Vasc Surg 2007;45:498-504

20. *Everett Y. Lam, Robert B. McLafferty, Lloyd M. Taylor*. Inferior epigastric artery pseudoaneurysm: A complication of paracentesis .J Vasc Surg 1998;28: 566-9.

21. *Seishiro Sekino, Hisato Takagi, Hajime Kubota*. Intercostal artery pseudoaneurysm due to stab Wound .J Vasc Surg 2005;42:352-362. *Scott M. Hovis, Herbert J Stern, Jeremiah Holleman*. Use of a percutaneous septal occlusion device to exclude a juxta-renal pseudoaneurysm of the abdominal aorta J Vasc Surg 2008; 48: 1328-31.

23. *Sunil S. Rayan, J. David Vega, Jack S. Shanewise*. Repair of mycotic aortic pseudoaneurysm with a stent graft using transesophageal echocardiography J Vasc Surg 2004;40: 567-70.)

24. *Jared R. Hylton, William C. Pevec*. Successful treatment of an iatrogenic right hepatic artery pseudoaneurysm and stenosis with a stent graft. J Vasc Surg 2010;51: 1510-3

25. *Grace S. Lee, John Brawley, Raymond Hung*. Complex subclavian artery pseudoaneurysm causing failure of endovascular stent repair with salvage by percutaneous thrombin injection.J Vasc Surg 2010;52:1058-60

26. *Rakesh Jeganathan, Denis W. Harkin, Patrick Lowry*. Iatrogenic subclavian artery pseudoaneurysm causing airway compromise: Treatment with percutaneous thrombin injection.J Vasc Surg 2004;40:371-4.

27. *Gautam V. Shrikhande, Sikandar Zaman Khan, Katherine Gallagher*. Endovascular management of superior mesenteric artery pseudoaneurysm.

J Vasc Surg 2011;53: 209-11

28. *Deron J. Tessier, William M. Stone, Richard J. Fowl.* Clinical features and management of splenic artery pseudoaneurysm: Case series and cumulative review of literature. J Vasc Surg 2003;38:969-74

29. *Rita Spirito, Piero Trabattoni, Giulio Pompilio*. Endovascular treatment of a post-traumatic tibial pseudoaneurysm and arteriovenous fistula: Case report and review of the literature J Vasc Surg 2007;45: 1076-9

30. *Steven M. Hertz, Bruce J. Brener*. Ultrasound-guided pseudoaneurysm compression: Efficacy after coronary stenting and angioplasty. J Vasc Surg 1997;26:913-8.

31. *Mourad Boufi, Hicham Belmir, Olivier Hartung*. Emergency stent graft implantation for ruptured visceral artery pseudoaneurysm. J Vasc Surg 2011;53:1625-31

32. *ZHU Xiao-li, NI Cai-fang, LIU Yi-zhi.* Treatment strategies and indications for interventional management of pseudoaneurysms. Chin Med J 2011;124 (12):1784-1789

33. *Subodh Arora, Michael A.Weber, Charles J. Fox.* Common femoral artery ligation and local debridement: A safe treatment for infected femoral artery pseudoaneurysms Journal of Vascular Surgery Volume 33, Number 5.page 990-993.

Annexure I: Ethical Clearance Letter

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No: 04425305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr. V. Arunagiri
PG in MCh Vascular Surgery
Madras Medical college
Chennai -3

Dear Dr. V. Arunagiri

The Institutional Ethics Committee of Madras Medical College reviewed and discussed your application for approval of the proposal entitled "Evaluating aetiologies, treatment strategies and optimizing outcomes in pseudoaneurysms " No. 21072011.

The following members of Ethics Committee were present in the meeting held on 21.07.2011 conducted at Madras Medical College, Chennai -3.

1.	Prof. S.K. Rajan, MD	-- Chairperson
2.	Prof. V. Kanagasabai, MD Dean, Madras Medical College, Chennai-3,	-- Deputy Chairman
3.	Prof. A. Sundaram, MD Vice Principal , Madras Medical College, Chennai -3	-- Member Secretary
4.	Prof R. Sathianathan , MD	-- Member
5.	Prof R. Nandhini, MD Director, Institute of Pharmacology, MMC, Ch-3	-- Member
6.	Prof. Geetha Subramanian MD. DM Prof & Head , Dept. of Cardiology, MMC, Ch-3	-- Member
7.	Prof. Pregna B. Dolia, MD Director , Institute of Biochemistry, MMC, Ch-3	-- Member
8.	Prof. C. Rajendiran, MD Director , Institute of Internal Medicine, MMC, Ch-3	-- Member
9.	Thiru. A. Ulaganathan Administrative Officer, MMC, Chennai -3	-- Layperson
10.	Thiru. S. Govindasamy . BA.BL	-- Lawyer
11.	Tmt. Arnold Soufina MA	-- Social Scientist

We approve the proposal to be conducted in its presented form

Sd /. Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information / informed consent and asks to be provided a copy of the final report

Member Secretary, Ethics Committee

Annexure II: Patient Consent Form

DEPARTMENT OF VASCULAR SURGERY,

MADRAS MEDICAL COLLEGE,CHENNAI.

The patients in this study will be required to undergo physical examination, laboratory investigations and radiological investigations like duplex ultrasound and computed tomography.

AUTHORISATION:

Name of the patient: D.O.B:

1) I agree entirely voluntarily to take part in this study. I am >= 18 years of age.
2) I have been given full explanation of the purpose of the study and information regarding the procedures involved and what will be expected out of me.
3) I understand that I am entirely free to withdraw from the study at any time and this withdrawal will not affect my future treatment or medical management.
4) I understand that the information in my medical record is essential to evaluate the result of the study. I agree to the release of this information on the understanding that it will be treated confidentially.
5) I understand that I will not be referred to by any name in any report concerning the study. In turn I cannot restrict the use of the result which arises from this study.
6) I agree for the clinical photographs taken during the course of the study and agree for the use of it in the future.

Signature/ thumb impression of the patient:
Date –

Signature of the supervising doctor:
Date –

Signature/ thumb impression of the witness:
Date –

Annexure III: Information Sheet

We are conducting a study on "**Evaluating etiologies, treatment strategies and optimizing outcomes in pseudoaneurysms**" among patients attending Vascular surgery OPD and inpatients of Vascular surgery department at Government General Hospital, Chennai .

The purpose of this study is to identify the patients presenting with pseudoaneurysm and assess their treatment outcomes including limb salvage rates and survival.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time. Your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of investigator Signature of participant.

Annexure IV: Pseudo Aneurysm - Case Proforma

Case No:

Name : **IP No :**
Age/Sex : **DOA :**
DOS : **DOD :**

Diagnosis: Anastomotic/Post Traumatic/ Iatrogenic/ Post AV access/Infective

others

History:

Swelling - duration
-H/O sudden increase in size
Associated (i) pain in limb – limb ischemia
(ii) bleeding
H/O herald bleed
H/O Neurological deficit
H/O Venous compression

Past H/O

H/O Surgery

H/O Trauma

H/O Cardiac ailment

DM HTN CAD RHD IE CKD

H/O Angiogram

Personal H/O

Smoking
Alcoholic

O/E

GC
Pallor
Icterus

Vitals

PR
BP
Hypotension at presentation:

Systemic Exams

Chest
CVS
P/A

	Right	Left		Right	Left
CFA			CCA		
POP			SCA		
DP			BRAC		
PT			RAD		
ABI			ULNAR		

L/E

Swelling -> size

- ➔ Pulsatile/Thrombosed
- ➔ Skin Breach
- ➔ Active bleeding
- ➔ Impending Rupture

Limb

Temp : Cold / Warm
Sensation: Present / Absent
Toe& Ankle movements: Present/Absent
Patch: Present/ Absent

Fistula – Thrill – Present/Absent

SCAR

Investigation:

Hemogram: Hb gm/dl TLC: cells/mm^3 DLC

RFT Bl.Urea mg/dl S.creatinine: mg/dl

Bl.Sugar:

ECHO

Duplex: Extremity

Culture Blood

Clot

Wall

Procedure:

- Ligation

- Reconstruction

- Conservative MGT

- Duplex Compression

Outcome Analysis

Primary:

Etiology

Presentation: Elective/Emergency

Indication for intervention:

Salvaged Limb:

Secondary

Bleeding :

Transfusion
Wound Infection

Foot Drop

AV Access Salvage

Mortality

Annexure V: Key to Master Chart

- **Sex** - Male =1, Female=2
- **Aetiology**
  1 = Anastomotic
  2 = Post traumatic
  3 = infective
  4 = Iatrogenic
  5 = Idiopathic
  6 = AV access related
- **Vessel**
  1=CFA 2=Popliteal 3=SFA 4=EIA 5=PTA
  6=Brachial 7=CIA 8=Radial 9=Aorta 10=Ulnar
  11=PFA 12=Subclavian 13=AVF 14=Cephalic Vein
  15=Graft
- **Symptoms**
  0= No 1= Yes. In Venous Compression 2= Communication
- **Clinical Presentation**
  0=Absent 1=Present
- **Culture**
  0=No Growth
  1=CONS (coagulase negative staph aureus)
  2=Staph.aureus
  3=E.coli
  4=Klebsiella Pneumoniae
- **Mode of presentation**
  1=Emergency
  2=Elective
- **Indication for intervention**
  1=Impending rupture
  2=Active bleeding
  3=Pain
  4=Distal ischemia
  5=Neurologic compression
  6=Venous Hypertension
  7=Steal
- **Limb outcome**
  1=Amputated
  2=Salvaged
- **Mortality**
  0=Alive
  1=Died